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Kawai et al.

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(45) Date of Patent: Aug. 2, 2016

(54) METHOD, APPARATUS, AND NON-TRANSITORY MEDIUM FOR GENERATING A SYNTHETIC IMAGE FROM A SERIES OF CAPTURED IMAGES

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(73) Assignee: **Sony Corporation** (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 805 days.

(21) Appl. No.: **12/925,422**

(22) Filed: **Oct. 21, 2010**

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(30) **Foreign Application Priority Data**

Nov. 20, 2009 (JP) P2009-264616

(51) **Int. Cl.**
H04N 5/232 (2006.01)
G11B 27/28 (2006.01)

(52) **U.S. Cl.**
CPC ***H04N 5/232*** (2013.01); ***G11B 27/28*** (2013.01); ***H04N 5/23232*** (2013.01); ***H04N 5/23293*** (2013.01)

(58) **Field of Classification Search**
CPC H04N 9/045; G06T 11/001
USPC 348/222.1, 211.11
See application file for complete search history.

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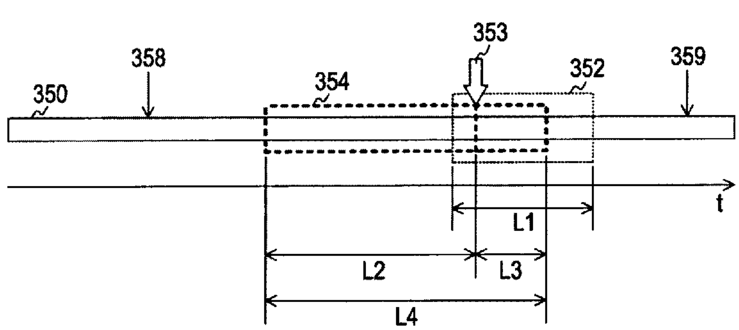
Primary Examiner — Roberto Velez
Assistant Examiner — Cynthia Segura
(74) *Attorney, Agent, or Firm* — Lerner, David, Littenberg, Krumholz & Mentlik, LLP

(57) **ABSTRACT**

An image processing apparatus includes: a specific sound detecting section detecting a specific sound generated during motion in a specific motion of a target object included in an image group including a plurality of images which continues in a time-series manner; a valid sound range setting section setting, as a valid sound range, a range in the time axis for determination of whether the specific sound is valid on the basis of a user manipulation; and a selecting section selecting a predetermined number of motion transition images representing transitions of the specific motion from a selection range of the image group in the time axis, with reference to a detection position of the specific sound in the time axis, in a case where the specific sound is detected in the set valid sound range.

15 Claims, 30 Drawing Sheets



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Office Action from Japanese Application No. 2009-264616, dated Jan. 7, 2014.

* cited by examiner

FIG. 1

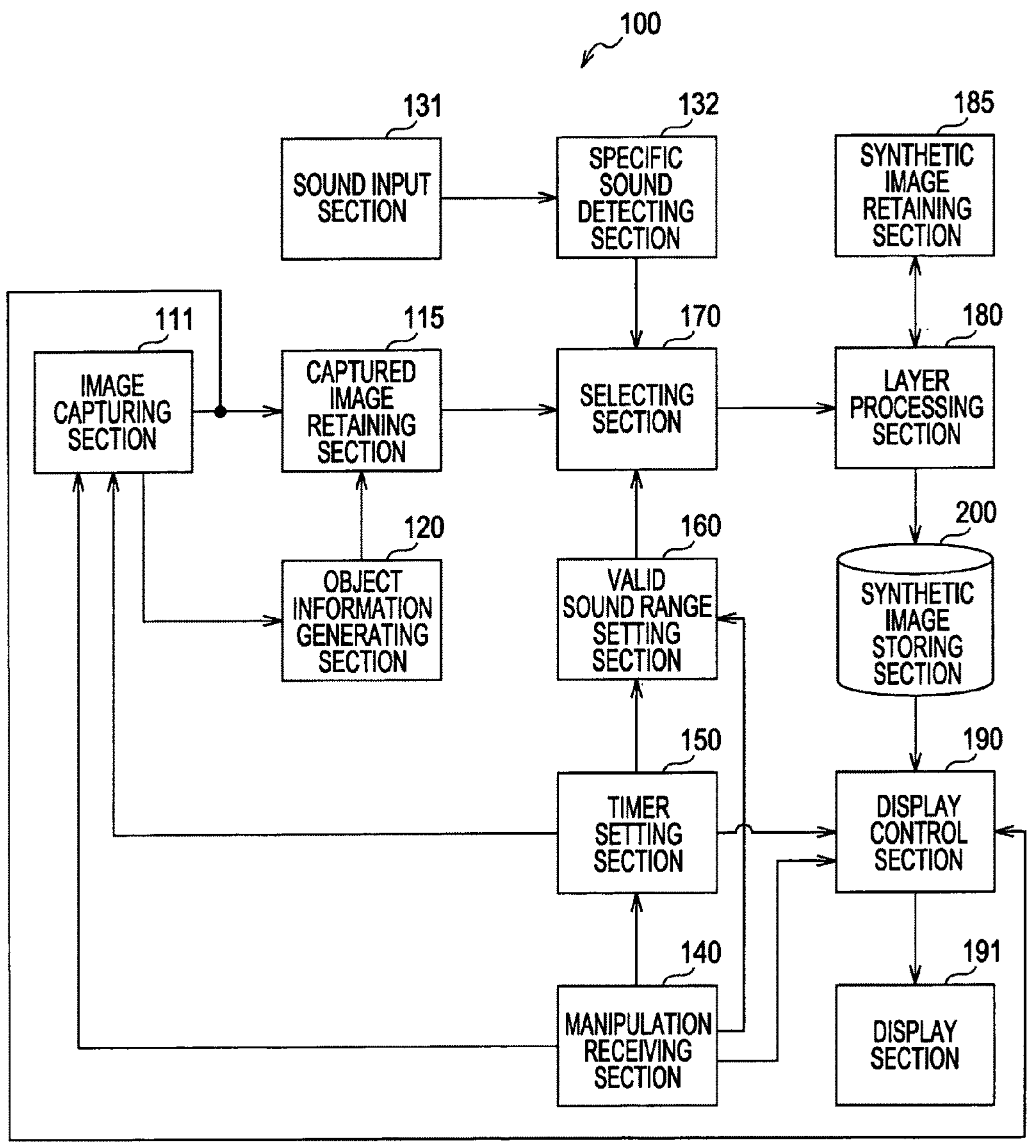
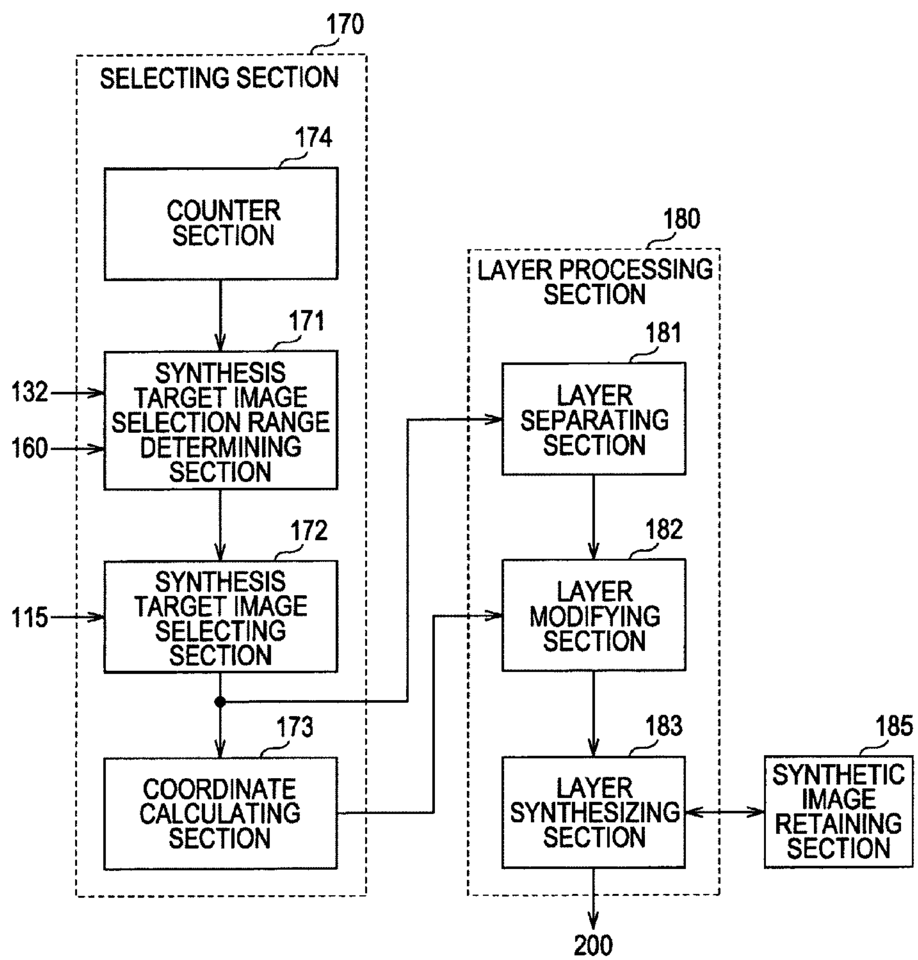

100
131
SOUND INPUT SECTION
132
SPECIFIC SOUND DETECTING SECTION
185
SYNTHETIC IMAGE RETAINING SECTION
111
IMAGE CAPTURING SECTION
115
CAPTURED IMAGE RETAINING SECTION
170
SELECTING SECTION
180
LAYER PROCESSING SECTION
120
OBJECT INFORMATION GENERATING SECTION
160
VALID SOUND RANGE SETTING SECTION
200
SYNTHETIC IMAGE STORING SECTION
150
TIMER SETTING SECTION
190
DISPLAY CONTROL SECTION
140
MANIPULATION RECEIVING SECTION
191
DISPLAY SECTION

FIG. 2



170
SELECTING SECTION
174
COUNTER SECTION
171
SYNTHESIS TARGET IMAGE SELECTION RANGE DETERMINING SECTION
132
160
172
SYNTHESIS TARGET IMAGE SELECTING SECTION
115
173
COORDINATE CALCULATING SECTION
180
LAYER PROCESSING SECTION
181
LAYER SEPARATING SECTION
182
LAYER MODIFYING SECTION
183
LAYER SYNTHESIZING SECTION
185
SYNTHETIC IMAGE RETAINING SECTION
200

FIG. 3A

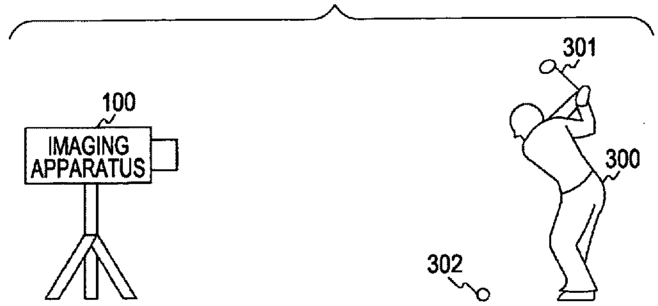


FIG. 3B

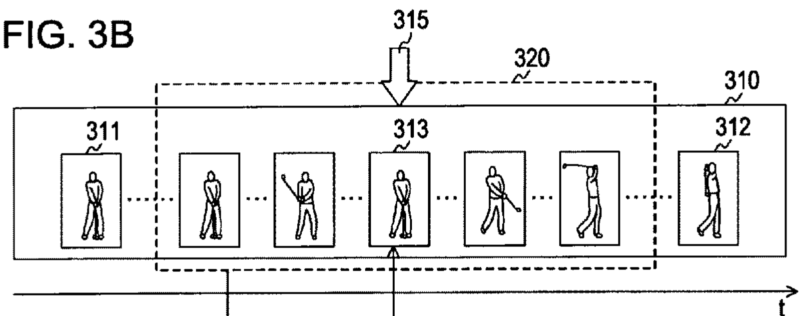


FIG. 3C

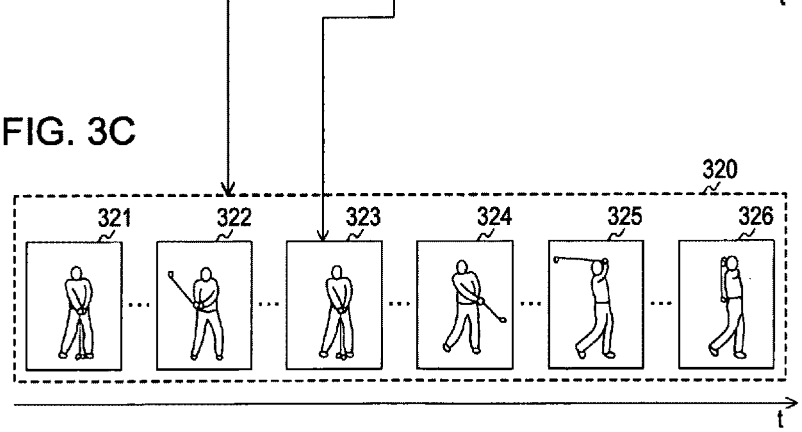


FIG. 4A

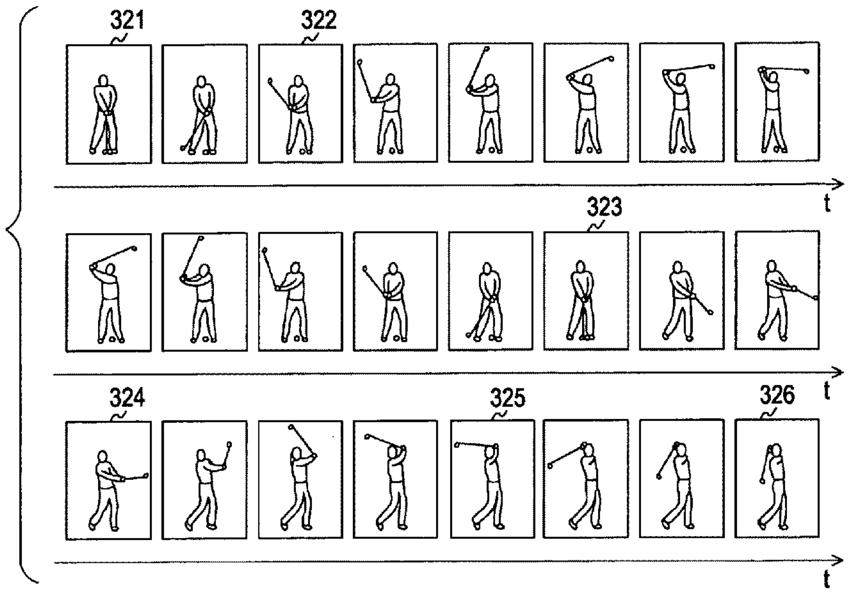


IMAGE SYNTHESIS

FIG. 4B

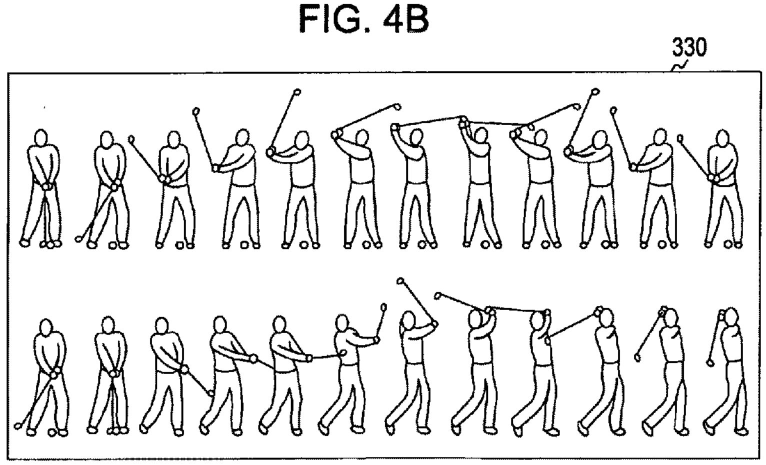


FIG. 5A

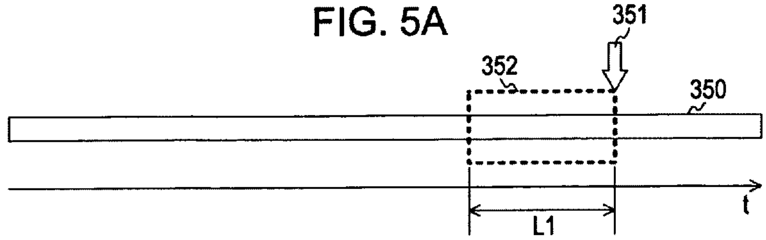


FIG. 5B

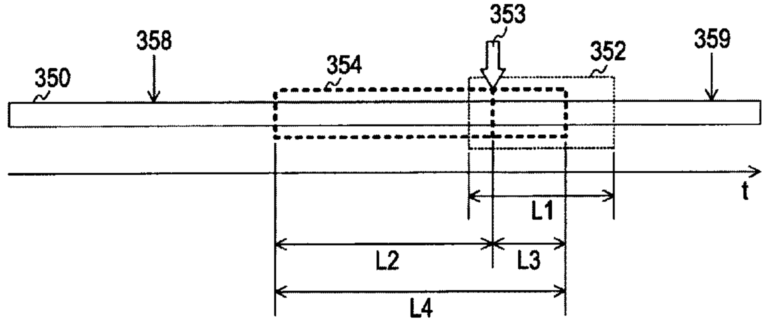


FIG. 5C

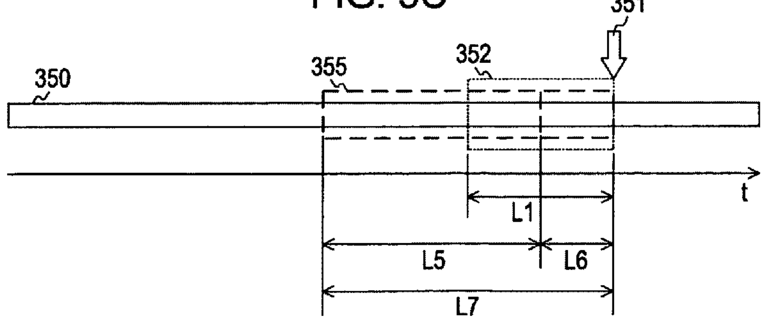
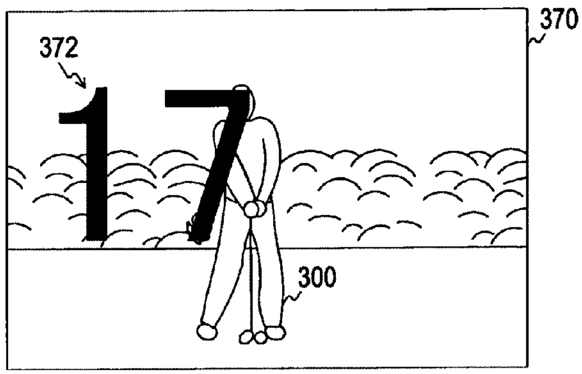


FIG. 6A



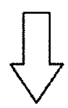


FIG. 6B

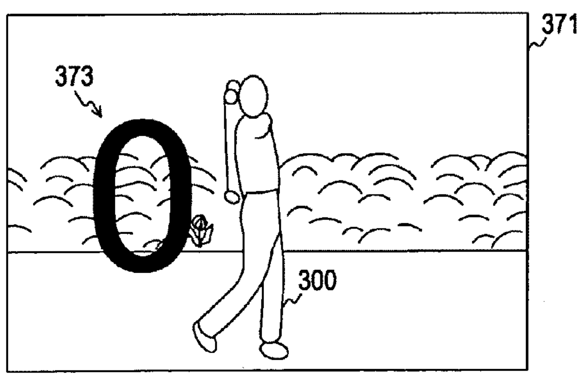


FIG. 7A

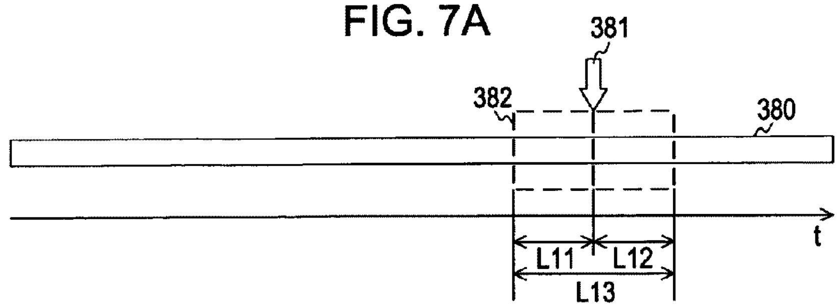


FIG. 7B

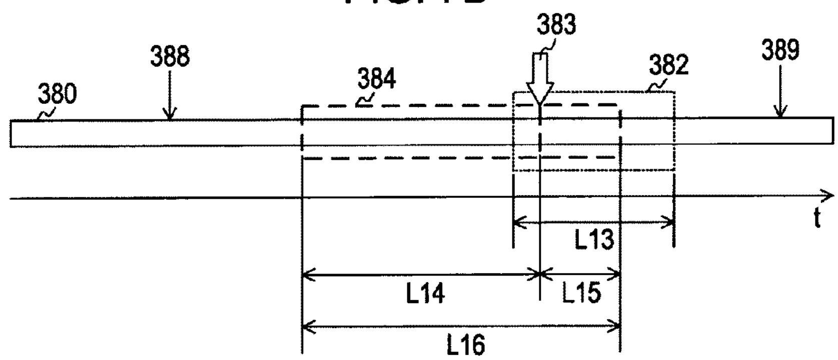


FIG. 7C

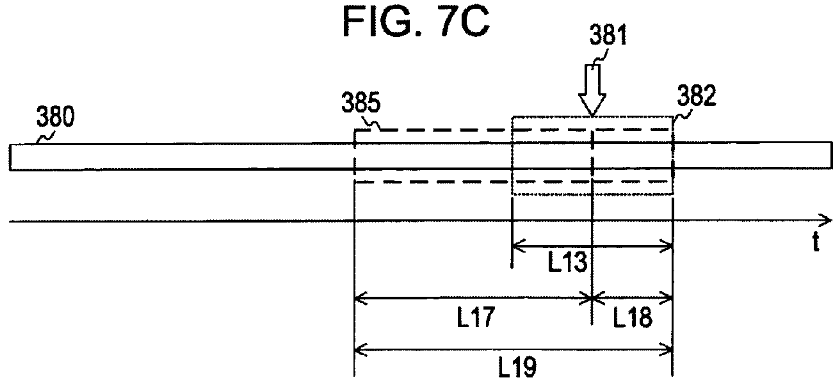


FIG. 8A

FIG. 8B

FIG. 8C

FIG. 8D

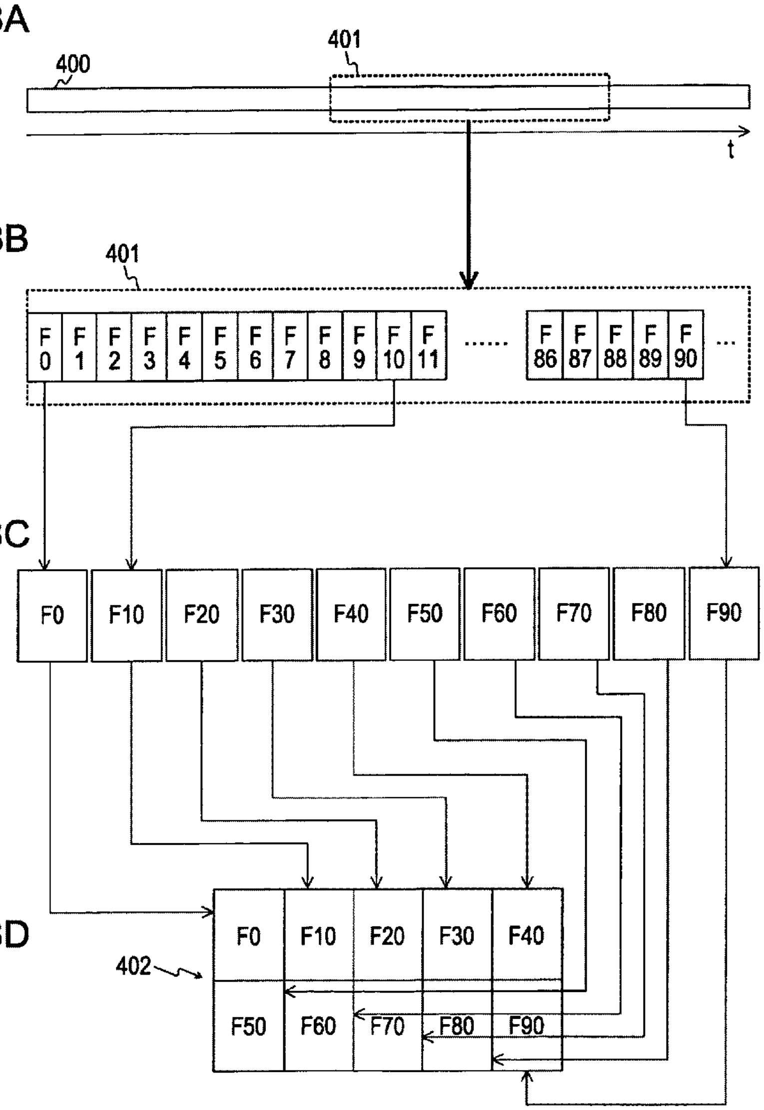


FIG. 9A

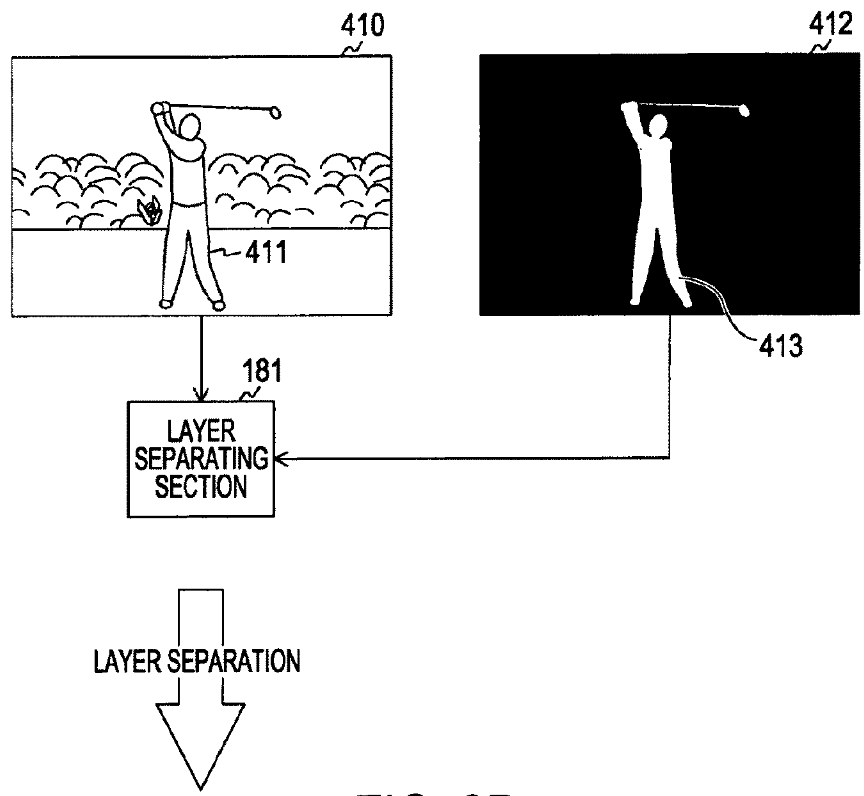

410
412
411
413
181
LAYER SEPARATING SECTION
LAYER SEPARATION

FIG. 9B

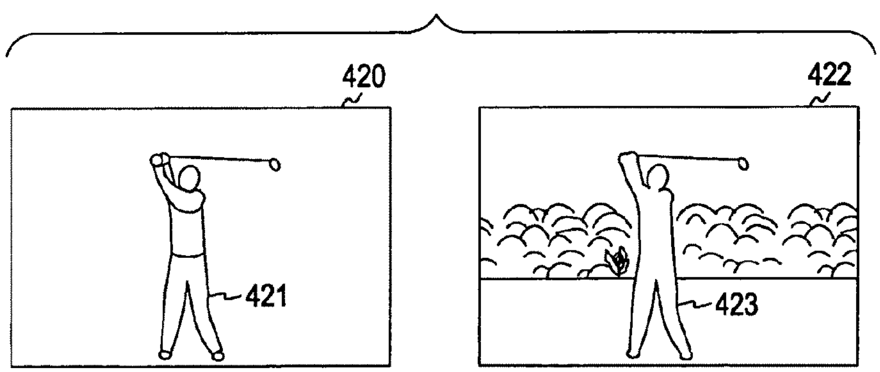

420
422
421
423

FIG. 10A

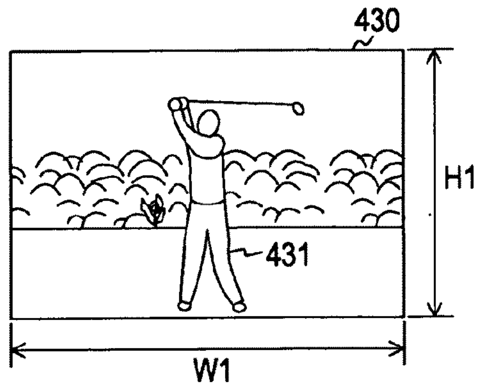


FIG. 10B

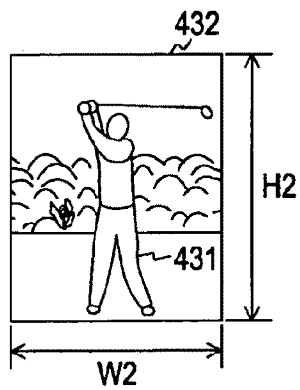


FIG. 10C

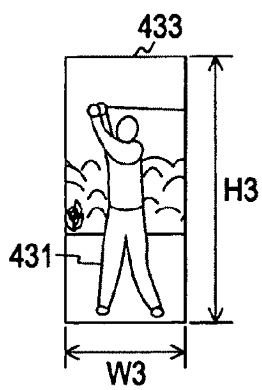


FIG. 11A

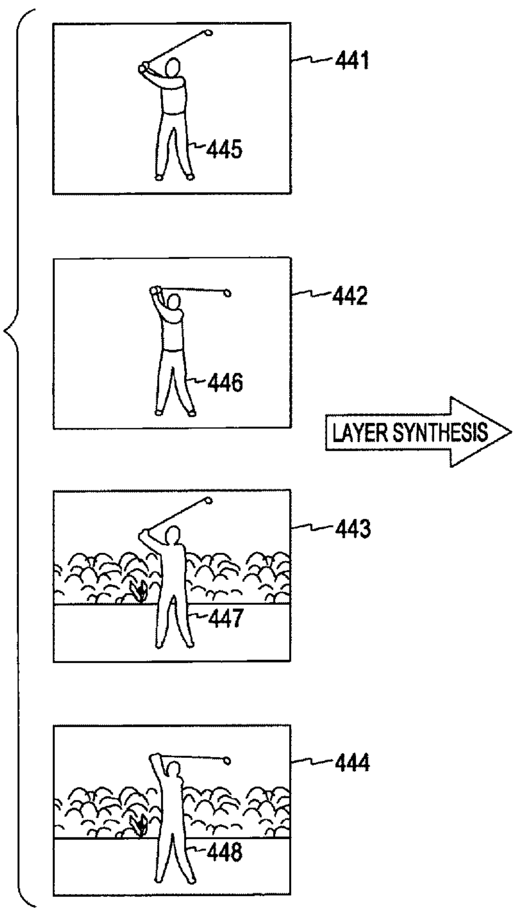


FIG. 11B

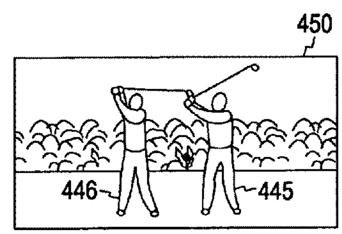


FIG. 12A

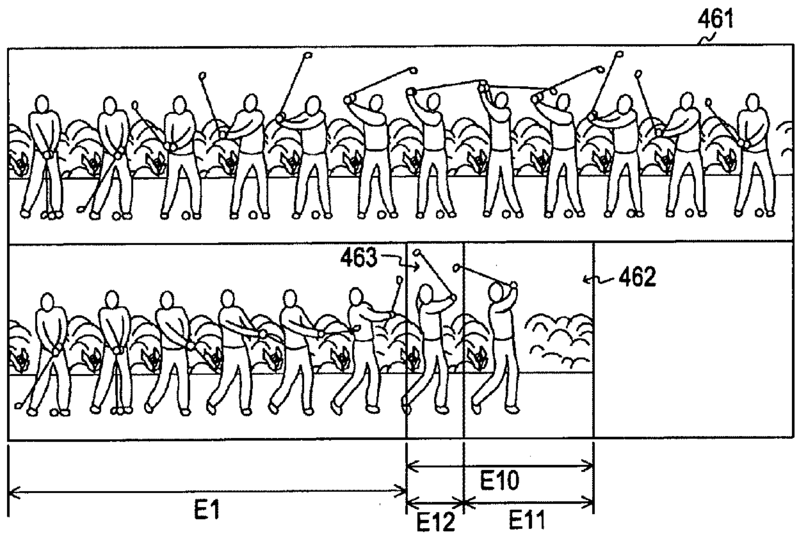


FIG. 12B

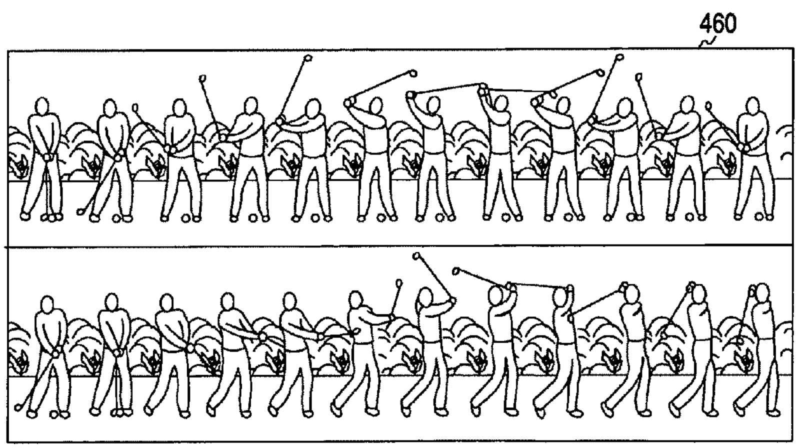


FIG. 13

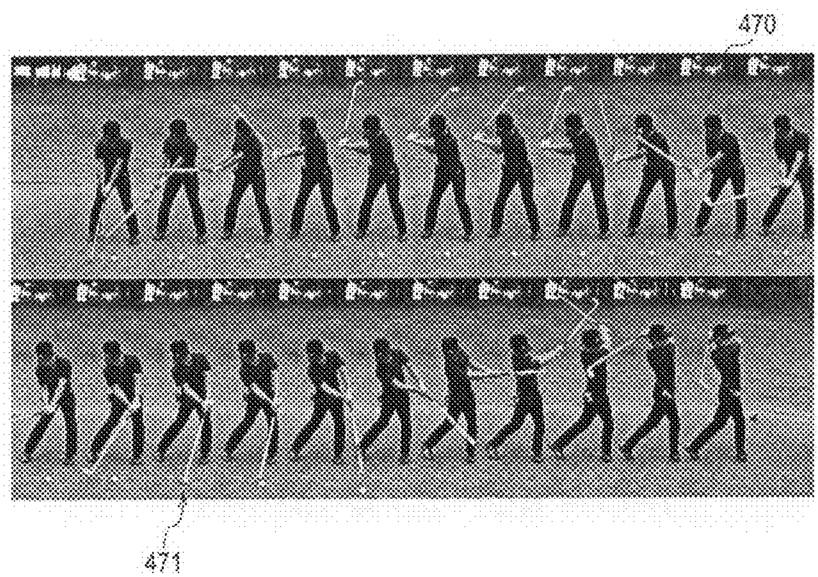


FIG. 14

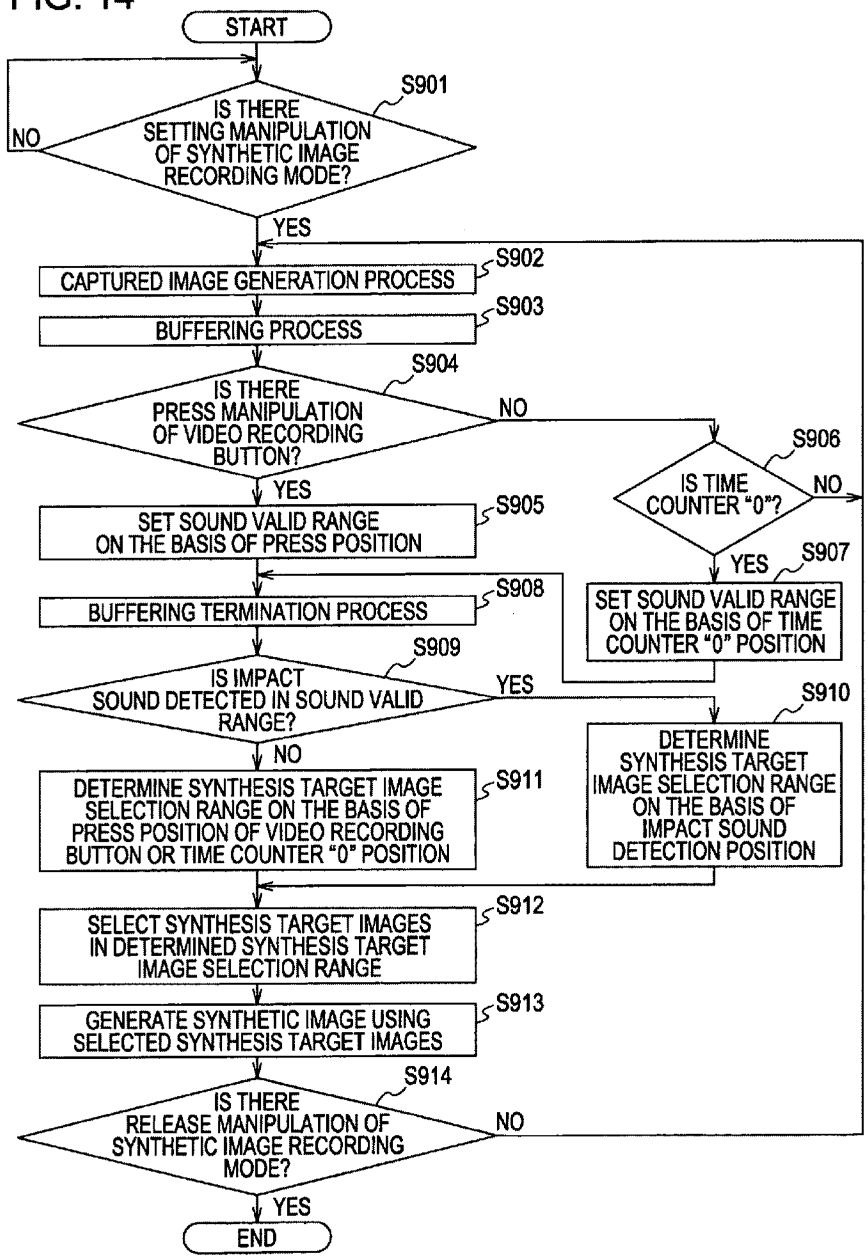

START
S901
IS THERE SETTING MANIPULATION OF SYNTHETIC IMAGE RECORDING MODE?
NO
YES
S902
CAPTURED IMAGE GENERATION PROCESS
S903
BUFFERING PROCESS
S904
IS THERE PRESS MANIPULATION OF VIDEO RECORDING BUTTON?
NO
YES
S905
SET SOUND VALID RANGE ON THE BASIS OF PRESS POSITION
S906
IS TIME COUNTER "0"?
NO
YES
S907
SET SOUND VALID RANGE ON THE BASIS OF TIME COUNTER "0" POSITION
S908
BUFFERING TERMINATION PROCESS
S909
IS IMPACT SOUND DETECTED IN SOUND VALID RANGE?
YES
NO
S910
DETERMINE SYNTHESIS TARGET IMAGE SELECTION RANGE ON THE BASIS OF IMPACT SOUND DETECTION POSITION
S911
DETERMINE SYNTHESIS TARGET IMAGE SELECTION RANGE ON THE BASIS OF PRESS POSITION OF VIDEO RECORDING BUTTON OR TIME COUNTER "0" POSITION
S912
SELECT SYNTHESIS TARGET IMAGES IN DETERMINED SYNTHESIS TARGET IMAGE SELECTION RANGE
S913
GENERATE SYNTHETIC IMAGE USING SELECTED SYNTHESIS TARGET IMAGES
S914
IS THERE RELEASE MANIPULATION OF SYNTHETIC IMAGE RECORDING MODE?
NO
YES
END

FIG. 15

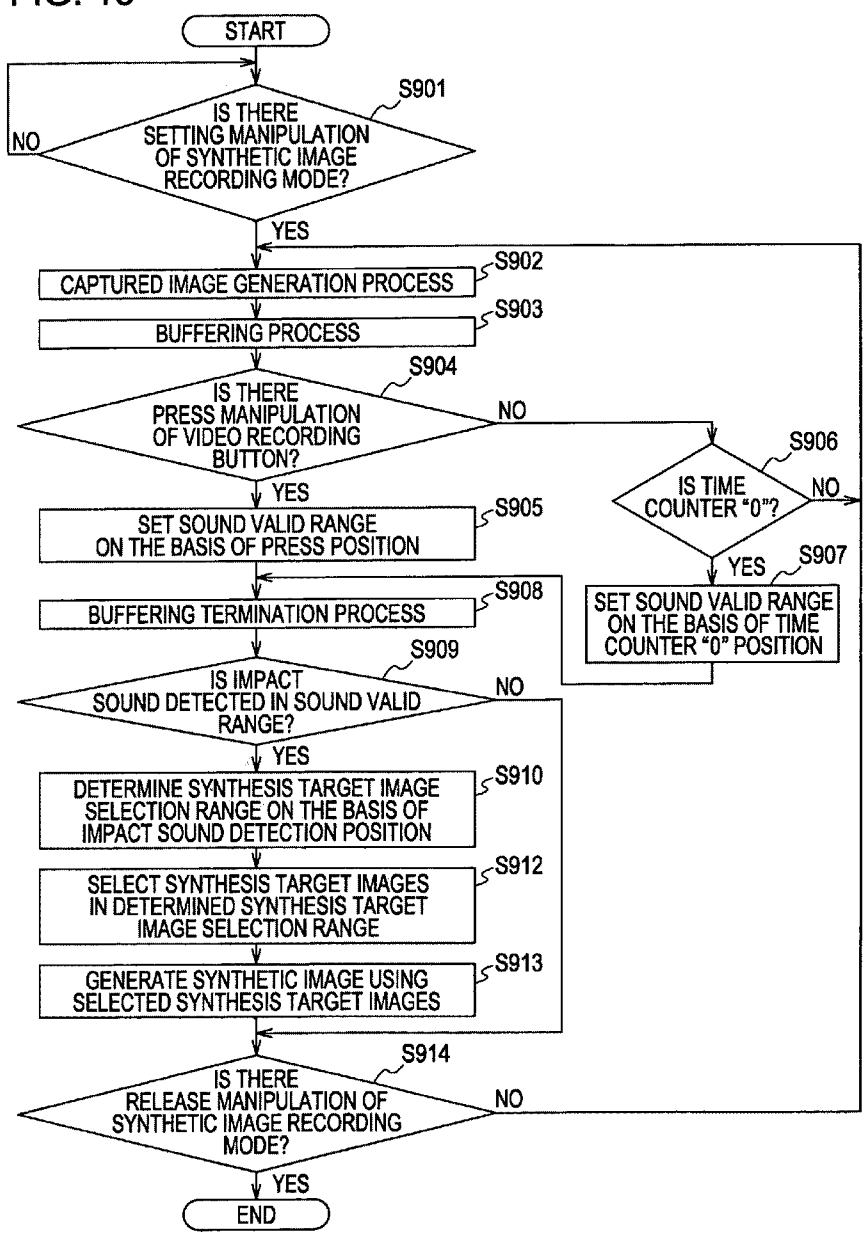

START
S901
IS THERE SETTING MANIPULATION OF SYNTHETIC IMAGE RECORDING MODE?
NO
YES
S902
CAPTURED IMAGE GENERATION PROCESS
S903
BUFFERING PROCESS
S904
IS THERE PRESS MANIPULATION OF VIDEO RECORDING BUTTON?
NO
YES
S905
SET SOUND VALID RANGE ON THE BASIS OF PRESS POSITION
S906
IS TIME COUNTER "0"?
NO
YES
S907
SET SOUND VALID RANGE ON THE BASIS OF TIME COUNTER "0" POSITION
S908
BUFFERING TERMINATION PROCESS
S909
IS IMPACT SOUND DETECTED IN SOUND VALID RANGE?
NO
YES
S910
DETERMINE SYNTHESIS TARGET IMAGE SELECTION RANGE ON THE BASIS OF IMPACT SOUND DETECTION POSITION
S912
SELECT SYNTHESIS TARGET IMAGES IN DETERMINED SYNTHESIS TARGET IMAGE SELECTION RANGE
S913
GENERATE SYNTHETIC IMAGE USING SELECTED SYNTHESIS TARGET IMAGES
S914
IS THERE RELEASE MANIPULATION OF SYNTHETIC IMAGE RECORDING MODE?
NO
YES
END

FIG. 16A

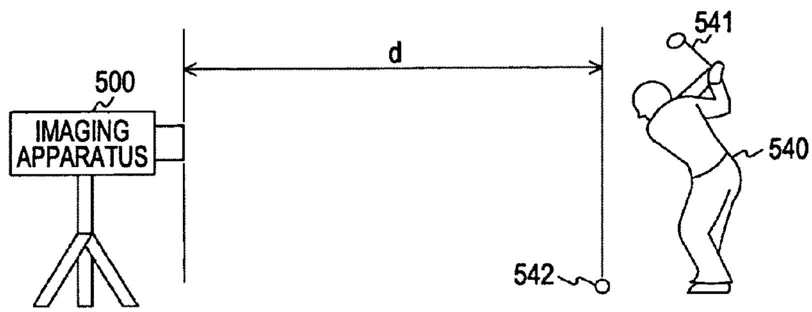


FIG. 16B

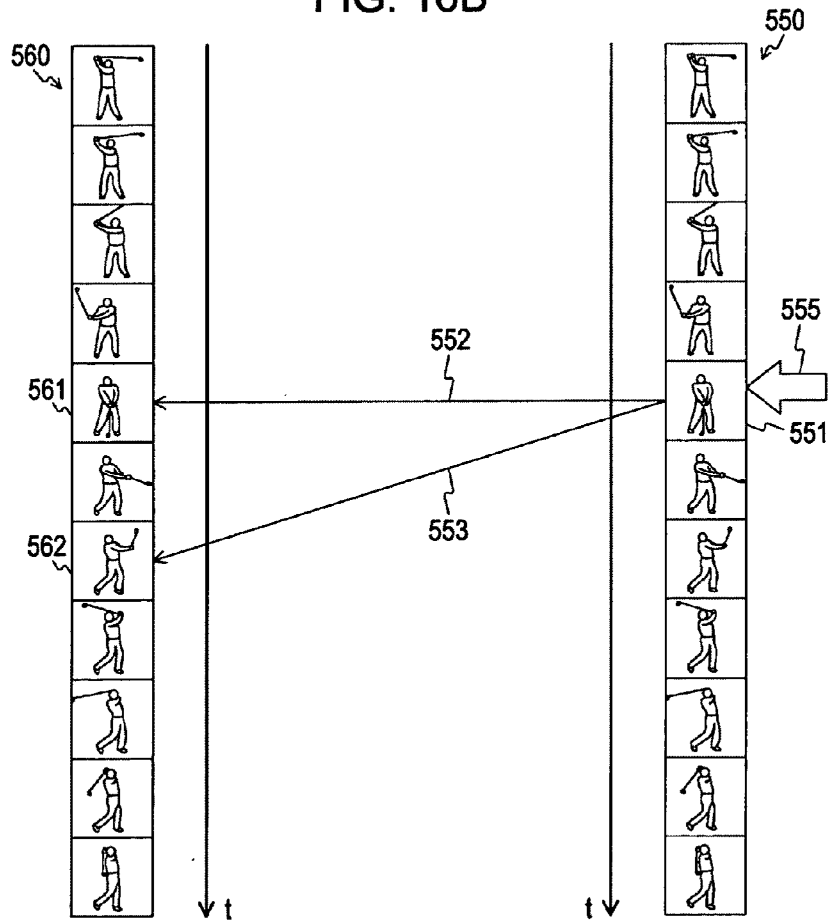


FIG. 17

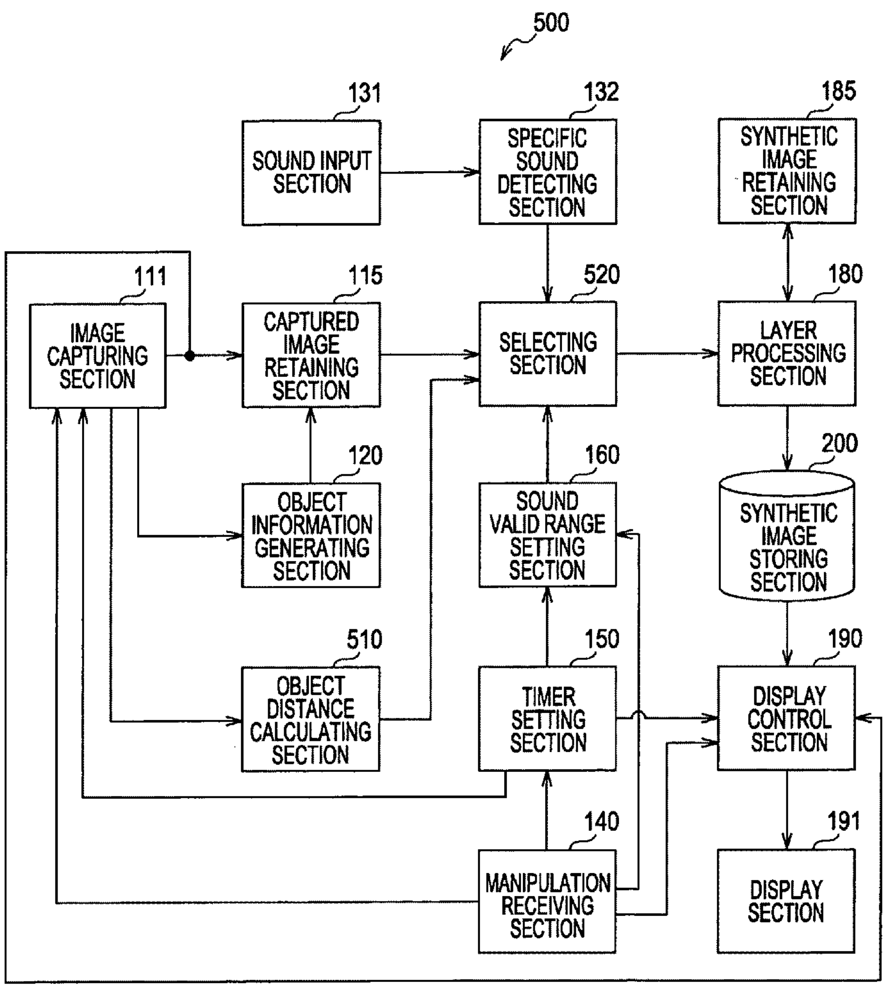

500
131
SOUND INPUT SECTION
132
SPECIFIC SOUND DETECTING SECTION
185
SYNTHETIC IMAGE RETAINING SECTION
111
IMAGE CAPTURING SECTION
115
CAPTURED IMAGE RETAINING SECTION
520
SELECTING SECTION
180
LAYER PROCESSING SECTION
120
OBJECT INFORMATION GENERATING SECTION
160
SOUND VALID RANGE SETTING SECTION
200
SYNTHETIC IMAGE STORING SECTION
510
OBJECT DISTANCE CALCULATING SECTION
150
TIMER SETTING SECTION
190
DISPLAY CONTROL SECTION
140
MANIPULATION RECEIVING SECTION
191
DISPLAY SECTION

FIG. 18A

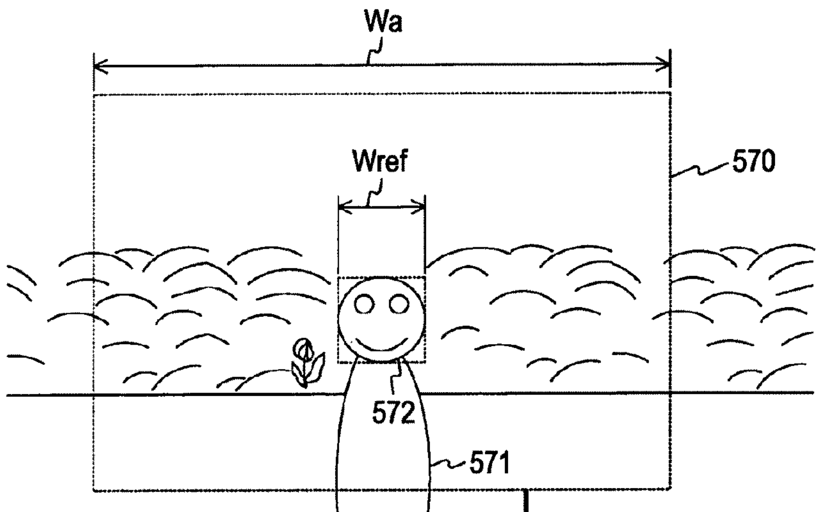


FIG. 18B

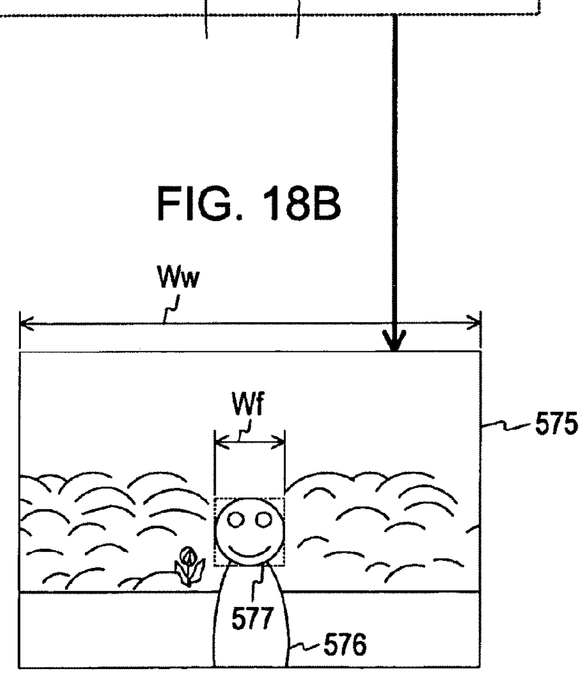


FIG. 19

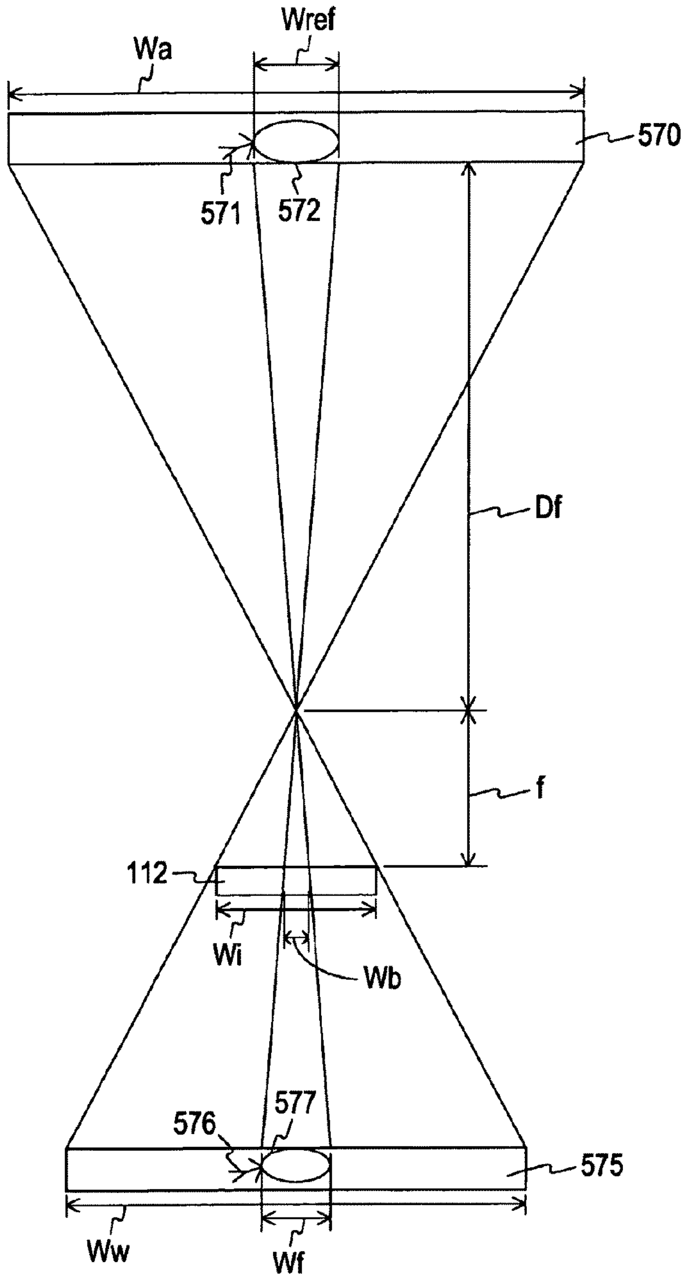


FIG. 20A

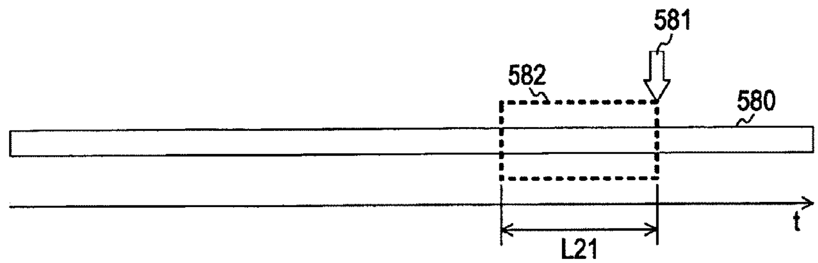


FIG. 20B

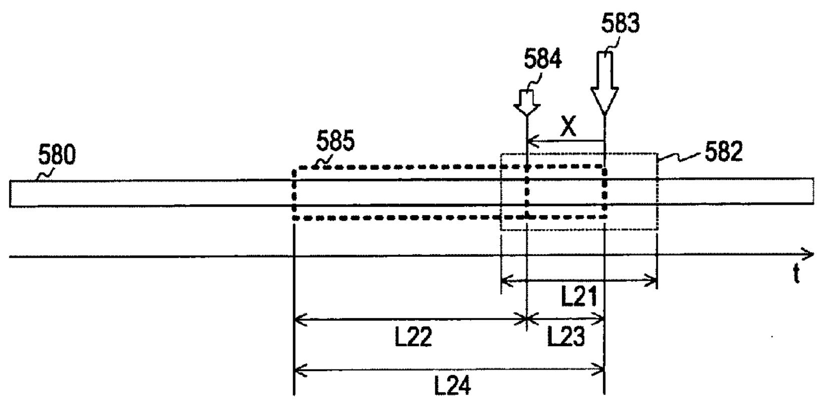


FIG. 21

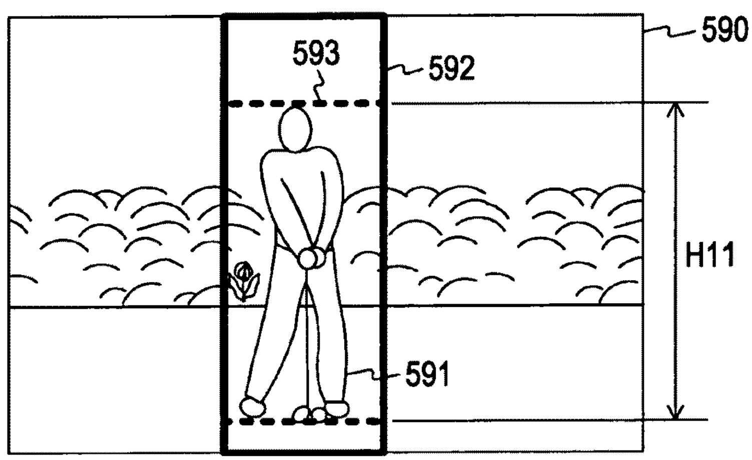


FIG. 22

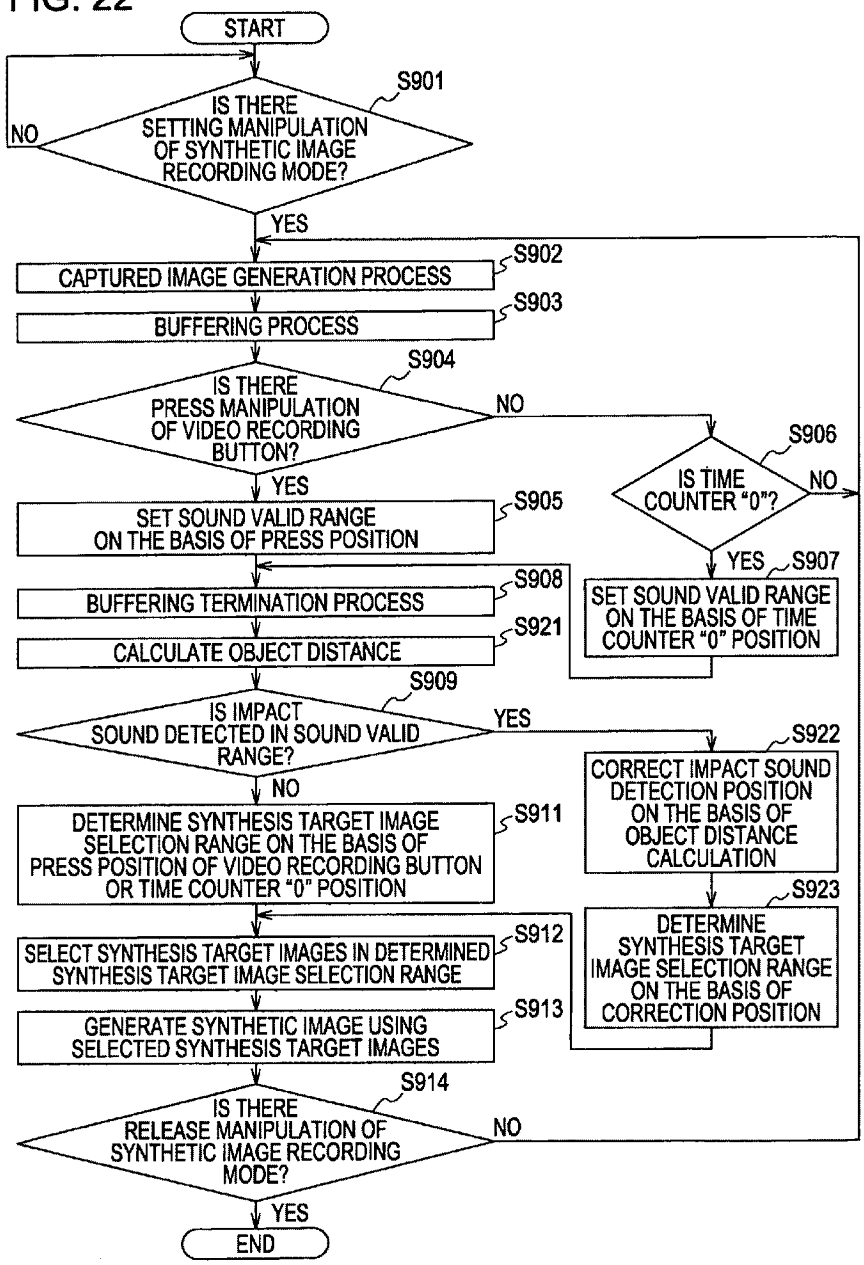

START
IS THERE SETTING MANIPULATION OF SYNTHETIC IMAGE RECORDING MODE?
S901
NO
YES
CAPTURED IMAGE GENERATION PROCESS
S902
BUFFERING PROCESS
S903
IS THERE PRESS MANIPULATION OF VIDEO RECORDING BUTTON?
S904
NO
YES
IS TIME COUNTER "0"?
S906
NO
YES
SET SOUND VALID RANGE ON THE BASIS OF PRESS POSITION
S905
SET SOUND VALID RANGE ON THE BASIS OF TIME COUNTER "0" POSITION
S907
BUFFERING TERMINATION PROCESS
S908
CALCULATE OBJECT DISTANCE
S921
IS IMPACT SOUND DETECTED IN SOUND VALID RANGE?
S909
YES
NO
CORRECT IMPACT SOUND DETECTION POSITION ON THE BASIS OF OBJECT DISTANCE CALCULATION
S922
DETERMINE SYNTHESIS TARGET IMAGE SELECTION RANGE ON THE BASIS OF PRESS POSITION OF VIDEO RECORDING BUTTON OR TIME COUNTER "0" POSITION
S911
DETERMINE SYNTHESIS TARGET IMAGE SELECTION RANGE ON THE BASIS OF CORRECTION POSITION
S923
SELECT SYNTHESIS TARGET IMAGES IN DETERMINED SYNTHESIS TARGET IMAGE SELECTION RANGE
S912
GENERATE SYNTHETIC IMAGE USING SELECTED SYNTHESIS TARGET IMAGES
S913
IS THERE RELEASE MANIPULATION OF SYNTHETIC IMAGE RECORDING MODE?
S914
NO
YES
END

FIG. 23

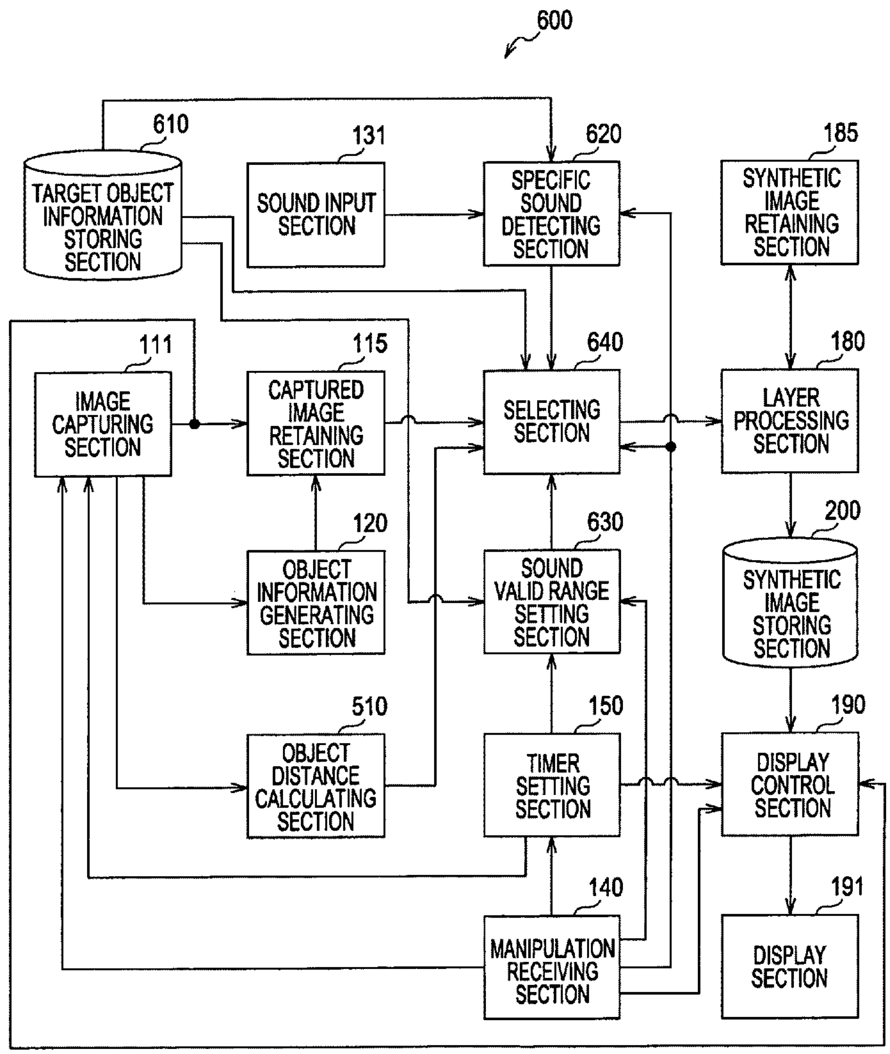

600
610
TARGET OBJECT INFORMATION STORING SECTION
131
SOUND INPUT SECTION
620
SPECIFIC SOUND DETECTING SECTION
185
SYNTHETIC IMAGE RETAINING SECTION
111
IMAGE CAPTURING SECTION
115
CAPTURED IMAGE RETAINING SECTION
640
SELECTING SECTION
180
LAYER PROCESSING SECTION
120
OBJECT INFORMATION GENERATING SECTION
630
SOUND VALID RANGE SETTING SECTION
200
SYNTHETIC IMAGE STORING SECTION
510
OBJECT DISTANCE CALCULATING SECTION
150
TIMER SETTING SECTION
190
DISPLAY CONTROL SECTION
140
MANIPULATION RECEIVING SECTION
191
DISPLAY SECTION

FIG. 24

610

	IMPACT SOUND (611)	HIGH SPEED MOTION RANGE (612)	SOUND VALID RANGE (613)	SYNTHESIS TARGET IMAGE SELECTION RANGE (614)
GOLF	SOUND GENERATED BY HITTING BALL DURING SWING	0.05 SECONDS AROUND IMPACT SOUND	SPECIFIC RANGE BEFORE PHOTOGRAPHING TRIGGER	1.5 SECONDS BEFORE AND 0.5 SECONDS AFTER IMPACT SOUND (TOTAL 2.0 SECONDS)
BASEBALL (BATTING)	SOUND GENERATED BY HITTING BALL DURING SWING	0.05 SECONDS AROUND IMPACT SOUND	SPECIFIC RANGE BEFORE PHOTOGRAPHING TRIGGER	1.5 SECONDS BEFORE AND 0.5 SECONDS AFTER IMPACT SOUND (TOTAL 2.0 SECONDS)
TENNIS (SERVICE)	SOUND GENERATED BY HITTING BALL	0.05 SECONDS AROUND IMPACT SOUND	RANGE FROM PHOTOGRAPHING TRIGGER UNTIL SOUND OF SPECIFIC VALUE OR HIGHER IS FIRSTLY DETECTED	2.5 SECONDS BEFORE AND 0.5 SECONDS AFTER IMPACT SOUND (TOTAL 3.0 SECONDS)
ROOF TILE BREAKING	SOUND GENERATED BY BREAKING ROOF TILES WITH HAND	0.1 SECONDS AROUND IMPACT SOUND	RANGE FROM PHOTOGRAPHING TRIGGER UNTIL SOUND OF SPECIFIC VALUE OR HIGHER IS FIRSTLY DETECTED	1.5 SECONDS BEFORE AND 0.5 SECONDS AFTER IMPACT SOUND (TOTAL 2.0 SECONDS)
FIREWORKS	SOUND AT THE MOMENT OF EXPLOSION IN THE SKY	0.1 SECONDS AROUND IMPACT SOUND	SPECIFIC RANGE BEFORE PHOTOGRAPHING TRIGGER	0.1 SECONDS BEFORE AND 5.1 SECONDS AFTER IMPACT SOUND (TOTAL 5.2 SECONDS)

FIG. 25

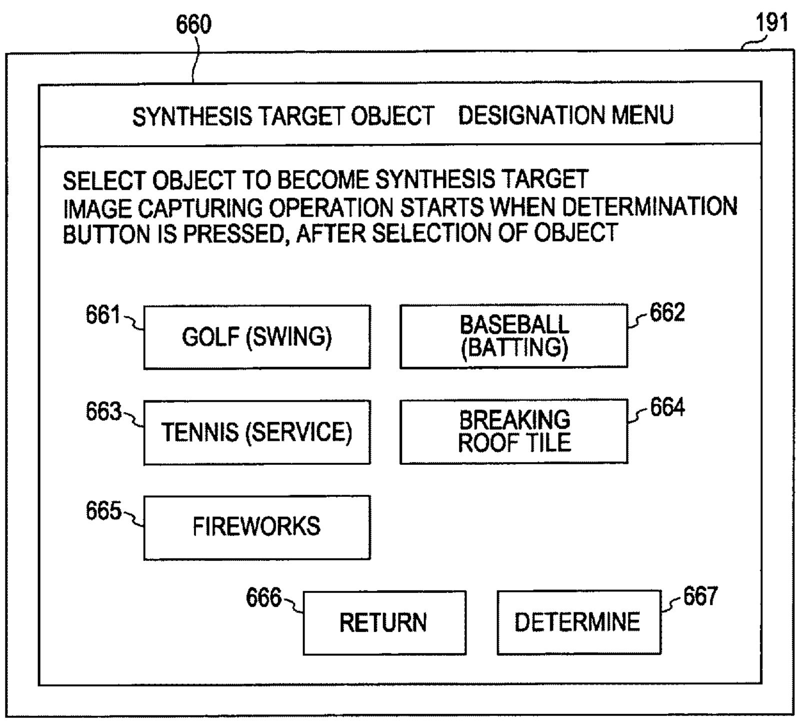

660
191
SYNTHESIS TARGET OBJECT DESIGNATION MENU
SELECT OBJECT TO BECOME SYNTHESIS TARGET
IMAGE CAPTURING OPERATION STARTS WHEN DETERMINATION
BUTTON IS PRESSED, AFTER SELECTION OF OBJECT
661
GOLF (SWING)
BASEBALL (BATTING)
662
663
TENNIS (SERVICE)
BREAKING ROOF TILE
664
665
FIREWORKS
666
RETURN
DETERMINE
667

FIG. 26A

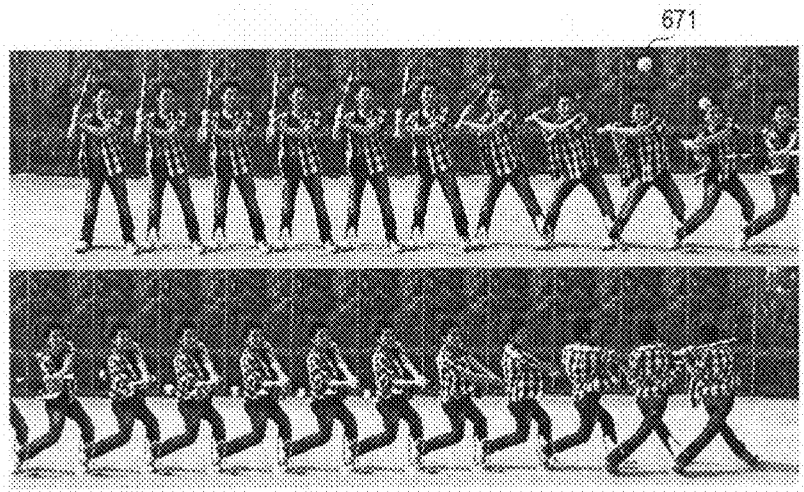


FIG. 26B

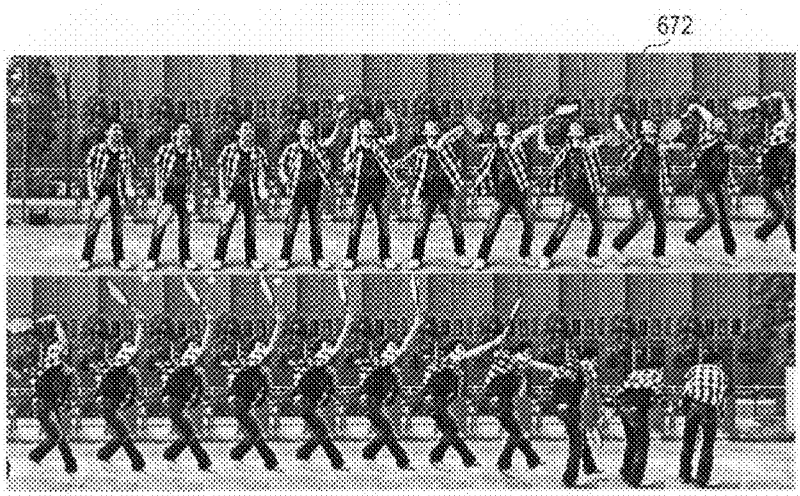


FIG. 27

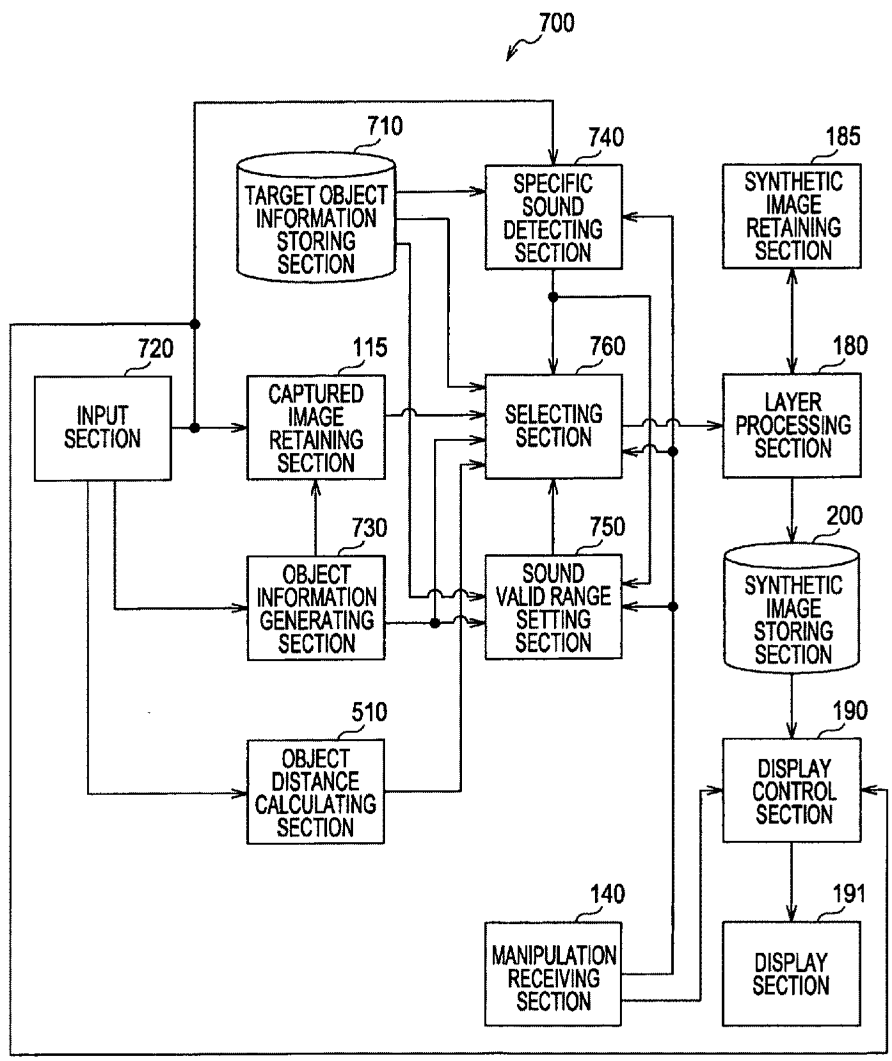

700
710
TARGET OBJECT INFORMATION STORING SECTION
740
SPECIFIC SOUND DETECTING SECTION
185
SYNTHETIC IMAGE RETAINING SECTION
720
INPUT SECTION
115
CAPTURED IMAGE RETAINING SECTION
760
SELECTING SECTION
180
LAYER PROCESSING SECTION
730
OBJECT INFORMATION GENERATING SECTION
750
SOUND VALID RANGE SETTING SECTION
200
SYNTHETIC IMAGE STORING SECTION
510
OBJECT DISTANCE CALCULATING SECTION
190
DISPLAY CONTROL SECTION
140
MANIPULATION RECEIVING SECTION
191
DISPLAY SECTION

FIG. 28

710

	IMPACT SOUND (711)	HIGH SPEED MOTION RANGE (712)	TRIGGER FOR DETERMINING SOUND VALID RANGE (713)	SOUND VALID RANGE (714)	SYNTHESIS TARGET IMAGE SELECTION RANGE (715)
GOLF	SOUND GENERATED BY HITTING BALL DURING SWING	0.05 SECONDS AROUND IMPACT SOUND	WHEN GREAT CHEER OF SPECTATORS IS DETECTED	SPECIFIC RANGE BEFORE TRIGGER	1.5 SECONDS BEFORE AND 0.5 SECONDS AFTER IMPACT SOUND (TOTAL 2.0 SECONDS)
BASEBALL (BATTING)	SOUND GENERATED BY HITTING BALL DURING SWING	0.05 SECONDS AROUND IMPACT SOUND	WHEN GREAT CHEER OF SPECTATORS IS DETECTED	SPECIFIC RANGE BEFORE TRIGGER	1.5 SECONDS BEFORE AND 0.5 SECONDS AFTER IMPACT SOUND (TOTAL 2.0 SECONDS)
TENNIS (SERVICE)	SOUND GENERATED BY HITTING BALL	0.05 SECONDS AROUND IMPACT SOUND	WHEN FACE TURNS UP FOR A PREDETERMINED TIME	RANGE FROM TRIGGER UNTIL SOUND OF SPECIFIC VALUE OR HIGHER IS FIRSTLY DETECTED	2.5 SECONDS BEFORE AND 0.5 SECONDS AFTER IMPACT SOUND (TOTAL 3.0 SECONDS)
ROOF TILE BREAKING	SOUND GENERATED BY BREAKING ROOF TILES WITH HAND	0.1 SECONDS AROUND IMPACT SOUND	WHEN FACE IS FULL OF FIGHTING SPIRIT	RANGE FROM TRIGGER UNTIL SOUND OF SPECIFIC VALUE OR HIGHER IS FIRSTLY DETECTED	1.5 SECONDS BEFORE AND 0.5 SECONDS AFTER IMPACT SOUND (TOTAL 2.0 SECONDS)
FIREWORKS	SOUND AT THE MOMENT OF EXPLOSION IN THE SKY	0.1 SECONDS AROUND IMPACT SOUND	WHEN DARK STATE IN SCREEN IS TRANSITED TO BRIGHT STATE	SPECIFIC RANGE BEFORE TRIGGER	0.1 SECONDS BEFORE AND 5.1 SECONDS AFTER IMPACT SOUND (TOTAL 5.2 SECONDS)

FIG. 29A

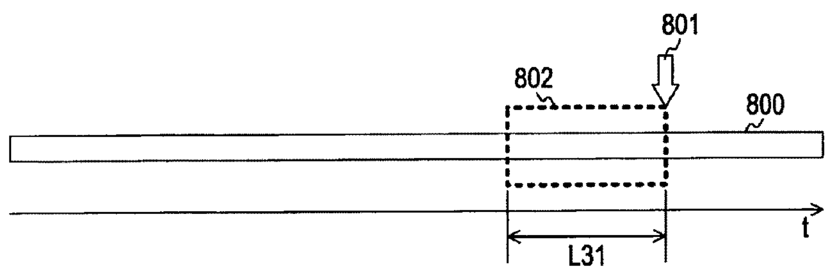


FIG. 29B

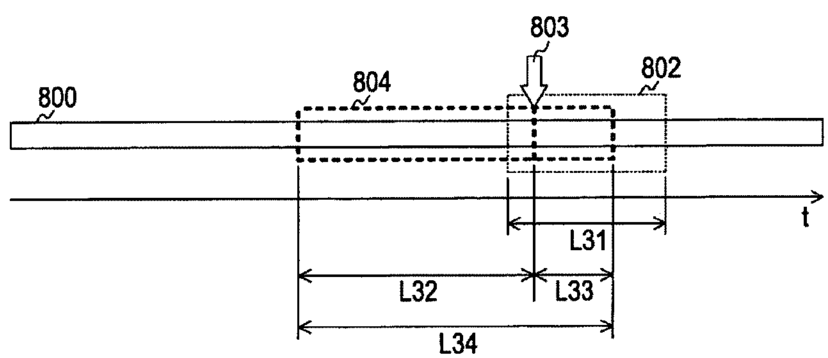


FIG. 30A

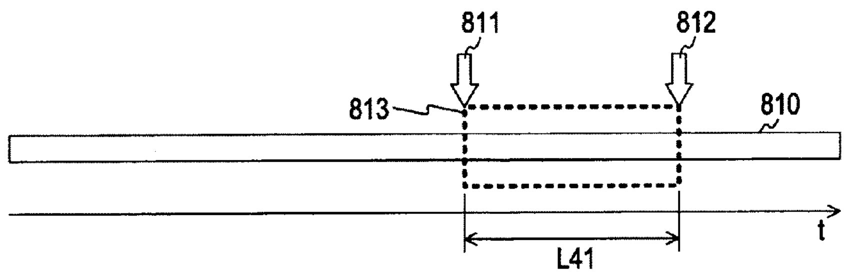
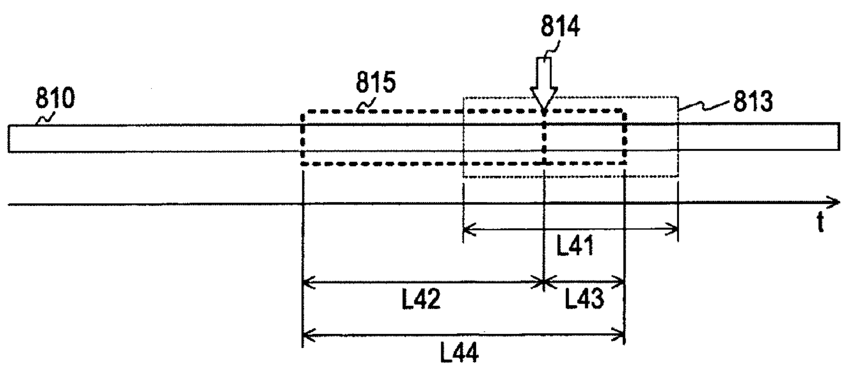


FIG. 30B



METHOD, APPARATUS, AND NON-TRANSITORY MEDIUM FOR GENERATING A SYNTHETIC IMAGE FROM A SERIES OF CAPTURED IMAGES

CROSS-REFERENCE TO RELATED APPLICATION

The present application claims priority from Japanese Patent Application No. JP 2009-264616 filed in the Japanese Patent Office on Nov. 20, 2009, the entire content of which is incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an image processing apparatus, and more particularly, to an image processing apparatus and an image processing method for processing a plurality of images which continues in a time-series manner, and a program for allowing the method to be executed on a computer.

2. Description of the Related Art

In recent years, image capturing apparatuses are widely used such as a digital still camera, a digital video camera (for example, integrated camera recorder) or the like which generates image data by imaging objects such as people and records the generated image data as contents such as image files, moving image files or the like. Further, recording of images of sport, for example, golf, baseball or the like, as contents is widely used such an image capturing apparatus. The contents (for example, moving image contents) recorded in this way can be used, for example, for checking actions in sport (for example, a golf swing or batting (baseball)).

For example, in the case of confirming a sport action (for example, a golf swing or batting (baseball)), there has been proposed a synthetic image generation method which generates an image representing motion transitions as a synthetic image so that the motion transitions can be easily grasped. For example, there is proposed an image capturing apparatus which selects a plurality of images from images which are continuously shot at predetermined intervals and generates a synthetic image using the selected plurality of images (refer to Japanese Unexamined Patent Application Publication No. 2009-44573 (FIG. 9), for example).

SUMMARY OF THE INVENTION

According to the above-described related art, it is possible to generate a synthetic image representing motion transitions of a person performing a golf swing, for example.

In this respect, for example, since the motion of a golf swing or batting (baseball) is performed in a relatively short time, when generating a synthetic image representing motion transitions, it is important to appropriately select images forming the synthetic target image. However, in the above-described related art, a range for selection of a plurality of images to be used for generating the synthetic image is determined with reference to the time of a start manipulation by a user. Thus, for example, in a case where the user is not accustomed to photographing or is a beginner, it may be difficult to appropriately perform the start manipulation with respect to the golf swing or batting (baseball) which are performed in a relatively short time.

Accordingly, for example, when selecting images representing the motion transitions of the golf swing or batting (baseball), it is important to select images included in an appropriate range.

Accordingly, it is desirable to provide a technique which can appropriately select images representing the transitions of a specific motion performed by a target object.

According to an embodiment of the present invention, there are provided an image processing apparatus including: a specific sound detecting section which detects a specific sound generated during motion in a specific motion performed by a target object included in an image group including a plurality of images which continues in a time-series manner; a valid sound range setting section which sets, as a valid sound range, a range in the time axis for determination of whether the specific sound detected by the specific sound detecting section is valid on the basis of a user manipulation; and a selecting section which selects a predetermined number of motion transition images representing transitions of the specific motion from a selection range of the image group in the time axis, with reference to a detection position of the specific sound in the time axis, in a case where the specific sound is detected in the set valid sound range, an image processing method and a program for allowing the method to be executed on a computer. Accordingly, it is possible to set the valid sound range on the basis of the user manipulation, and to select the predetermined number of motion transition images from the selection range, with reference to the detection position of the specific sound, in the case where the specific sound is detected in the set valid sound range.

In this embodiment, the user manipulation may be a specific manipulation received when the specific motion is terminated or a timer setting manipulation for such a setting that a termination time of the specific motion becomes a termination time of a time counter, and the valid sound range setting section may set the valid sound range with reference to a position in the time axis where the specific manipulation is received in a case where the user manipulation is the specific manipulation, and may set the valid sound range with reference to the termination time of the time counter by means of the timer setting manipulation in a case where the user manipulation is the timer setting manipulation. Accordingly, it is possible to set the valid sound range with reference to the position where the specific manipulation is received in the case where the user manipulation is the specific manipulation, and to set the valid sound range with reference to the termination time of the time counter by means of the timer setting manipulation in the case where the user manipulation is the timer setting manipulation.

In this embodiment, the valid sound range setting section may narrow the valid sound range set in the case where the user manipulation is the specific manipulation compared with the valid sound range set in the case where the user manipulation is the timer setting manipulation. Accordingly, it is possible to narrow the valid sound range set in the case where the user manipulation is the specific manipulation compared with the valid sound range set in the case where the user manipulation is the timer setting manipulation.

In this embodiment, the apparatus may further include a determining section which determines, as the selection range, a predetermined range before and after the detection position, in the time axis, of the specific sound detected in the set valid sound range, and the selecting section may select the motion transition images in the determined selection range. Accordingly, it is possible to determine, as the selection range, the predetermined range before and after the detection position of the specific sound detected in the set valid sound range, and to select the motion transition images in the determined selection range.

In this embodiment, the apparatus may further include: an object distance calculating section which calculates a distance to the target object; and a delay time calculating section which calculates a delay time of the detected specific sound on the basis of the calculated distance, and the selecting section may correct the detection position of the detected specific sound in the time axis on the basis of the calculated delay time and selects the motion transition images from the selection range, with reference to the corrected detection position, in a case where the corrected detection position exists in the set valid sound range. Accordingly, it is possible to calculate the distance to the target object, calculate the delay time of the detected specific sound on the basis of the calculated distance, correct the detection position of the detected specific sound on the basis of the calculated delay time, and select the motion transition images from the selection range, with reference to the corrected detection position, in the case where the corrected detection position exists in the set valid sound range.

In this embodiment, the selecting section may compress a selection interval in a range narrower than the selection range having, as a central position, the detection position of the specific sound in the time axis compared with other selection intervals, with respect to the selection interval of the motion transition images in the selection range. Accordingly, it is possible to compress the selection interval in the range narrower than the selection range having, as the central position, the detection position of the specific sound, compared with the other selection intervals, with respect to the selection interval of the motion transition images in the selection range.

In this embodiment, the apparatus may further include a synthetic image generating section which generates a synthetic image representing the motion transitions of the target object by arranging and synthesizing the plurality of selected motion transition images in a time-series manner. Accordingly, it is possible to arrange and synthesize the plurality of selected motion transition images in a time-series manner, to thereby generate the synthetic image representing the motion transitions of the target object.

In this embodiment, the apparatus may further include: a storing section which stores the specific sounds and the valid sound ranges relating to a plurality of types of specific motions; a manipulation receiving section which receives a designating manipulation for designating a desired specific motion from among the plurality of types of specific motions in which the specific sounds and the valid sound ranges are stored. Here, the specific sound detecting section may detect the specific sound relating to the designated specific motion, and the valid sound range setting section may set the valid sound range relating to the designated specific motion on the basis of the user manipulation. Accordingly, when the designating manipulation for designating the desired specific motion from among the plurality of types of specific motions is received, it is possible to detect the specific sound relating to the designated specific motion, and to set the valid sound range relating to the designated specific motion on the basis of the user manipulation.

In this embodiment, the valid sound range setting section may set the valid sound range on the basis of a user manipulation relating to an image capturing operation when the image group is generated.

According to another embodiment of the present invention, there are provided an image processing apparatus including: a specific sound detecting section which detects a specific sound generated during motion in a specific motion performed by a target object included in an image group including a plurality of images which continue in a time-series manner; a specific change detecting section which detects a specific change in the time axis between the respective images forming the image group; a valid sound range setting section which sets, as a valid sound range, a range in the time axis for determination of whether the specific sound detected by the specific sound detecting section is valid on the basis of a position in the time axis in which the specific change is detected; and a selecting section which selects a predetermined number of motion transition images representing transitions of the specific motion from a selection range of the image group in the time axis, with reference to a detection position of the specific sound in the time axis, in a case where the specific sound is detected in the set valid sound range, an image processing method and a program for allowing the method to be executed on a computer. Accordingly, it is possible to set the valid sound range on the basis of the position in which the specific change is detected, and to select the predetermined number of motion transition images from the selection range, with reference to the detection position of the specific sound, in the case where the specific sound is detected in the set valid sound range.

In this embodiment, the specific change detecting section may detect the specific change using at least one of a characteristic amount extracted from each image forming the image group and a characteristic amount extracted on the basis of a sound relating to each image forming the image group. Accordingly, it is possible to detect the specific change using at least one of the characteristic amount extracted from each image forming the image group and the characteristic amount extracted on the basis of the sound relating to each image forming the image group.

According to the embodiments of the present invention, it is possible to appropriately select the images representing the transitions of the specific motion performed by the target object.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram illustrating an example of a functional configuration of an image capturing apparatus according to a first embodiment of the present invention.

FIG. **2** is a block diagram illustrating an example of a functional configuration of a selecting section and a layer processing section according to a second embodiment of the present invention.

FIGS. **3**A, **3**B and **3**C are diagrams schematically illustrating the positional relation between an image capturing apparatus and a person who is an image capturing target, and the relation between moving images generated from the positional relation, according to a first embodiment of the present invention.

FIGS. **4**A and **4**B are diagrams illustrating an example of synthesis target images selected by a synthesis target image selecting section and a synthetic image generated by a layer processing section, according to a first embodiment of the present invention.

FIGS. **5**A, **5**B and **5**C are diagrams schematically illustrating a setting method of a valid sound range by a valid sound range setting section and a determination method of a synthesis target image selection range by a synthesis target image selection range determining section, according to a first embodiment of the present invention.

FIGS. **6**A and **6**B are diagrams illustrating an example of transitions of a display screen displayed on a display section according to a first embodiment of the present invention.

FIGS. **7**A, **7**B and **7**C are diagrams schematically illustrating a setting method of a valid sound range by a valid sound range setting section and a determination method of a synthesis target image selection range by a synthesis target image selection range determining section, according to a first embodiment of the present invention.

FIGS. **8**A, **8**B, **8**C and **8**D are diagrams schematically illustrating an example of a flow of a selection process of synthesis target images by a selecting section and a generation process of a synthetic image by a layer processing section, according to a first embodiment of the present invention.

FIGS. **9**A and **9**B are diagrams schematically illustrating a separation method of synthesis target images by a layer separating section according to a first embodiment of the present invention.

FIGS. **10**A, **10**B and **10**C are diagrams schematically illustrating an image which is a target of a modification process by a layer modifying section and an image which is modified by the layer modifying apparatus, according to a first embodiment of the present invention.

FIGS. **11**A and **11**B are diagrams schematically illustrating a synthesis method by a layer synthesizing section according to a first embodiment of the present invention.

FIGS. **12**A and **12**B are diagrams schematically illustrating a synthesis method of synthesis target images by a layer synthesizing section according to a first embodiment of the present invention.

FIG. **13** is a diagram illustrating an example of a synthetic image generated by a layer processing section according to a first embodiment of the present invention.

FIG. **14** is a flowchart illustrating an example of a process procedure of a synthetic image generation process by an image capturing apparatus according to a first embodiment of the present invention.

FIG. **15** is a flowchart illustrating an example of a process procedure of a synthetic image generation process by an image capturing apparatus according to a first embodiment of the present invention.

FIGS. **16**A and **16**B are diagrams illustrating the distance between an image capturing apparatus and a target object, and the relation between a generation position of an impact sound and an arrival position thereof, according to a second embodiment of the present invention.

FIG. **17** is a block diagram illustrating an example of a functional configuration of an image capturing apparatus according to a second embodiment of the present invention.

FIGS. **18**A and **18**B are diagrams schematically illustrating an image capturing range which is an image capturing target by an image capturing section and a captured image displayed on a display section, according to a second embodiment of the present invention.

FIG. **19** is a top view schematically illustrating the positional relation between an image capturing range which is an image capturing target by an image capturing section and a captured image displayed on a display section, according to a second embodiment of the present invention.

FIGS. **20**A and **20**B are diagrams schematically illustrating a setting method of a valid sound range by a valid sound range setting section and a determination method of a synthesis target image selection range by a synthesis target image selection range determining section, according to a second embodiment of the present invention.

FIG. **21** is a diagram illustrating a display example in a display section according to a second embodiment of the present invention.

FIG. **22** is a flowchart illustrating an example of a process procedure of a synthetic image generation process by an image capturing apparatus according to a second embodiment of the present invention.

FIG. **23** is a block diagram illustrating an example of a functional configuration of an image capturing apparatus according to a third embodiment of the present invention.

FIG. **24** is a diagram illustrating an example of stored contents of a target object information storing section according to a third embodiment of the present invention.

FIG. **25** is a diagram illustrating a display example (display screen) of a display section according to a third embodiment of the present invention.

FIGS. **26**A and **26**B are diagrams illustrating an example of a synthetic image generated by a layer processing section according to a third embodiment of the present invention.

FIG. **27** is a block diagram illustrating an example of a functional configuration of an image processing apparatus according to a fourth embodiment of the present invention.

FIG. **28** is a diagram illustrating an example of stored contents of a target object information storing section according to a fourth embodiment of the present invention.

FIGS. **29**A and **29**B are diagrams schematically illustrating a setting method of a valid sound range by a valid sound range setting section and a determination method of a synthesis target image selection range by a synthesis target image selection range determining section, according to a fourth embodiment of the present invention.

FIGS. **30**A and **30**B are diagrams schematically illustrating a setting method of a valid sound range by a valid sound range setting section and a determination method of a synthesis target image selection range by a synthesis target image selection range determining section, according to a fourth embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Hereinafter, embodiments for carrying out the present invention will be described in the following order.

1. First embodiment (synthetic image generation control: an example of setting a valid sound range on the basis of user manipulation)
2. Second embodiment (synthetic image generation control: an example of calculating an object distance and correcting an impact sound detecting position)
3. Third embodiment (synthetic image generation control: an example of designating a desired object from a plurality of objects and generating a synthetic image relating to the object)
4. Fourth embodiment (synthetic image generation control: an example of generating a synthetic image in recorded image contents)

1. First Embodiment

[Configuration Example of Image Capturing Apparatus]

FIG. **1** is a block diagram illustrating an example of a functional configuration of an image capturing apparatus **100** according to a first embodiment of the present invention. The image capturing apparatus **100** includes an image capturing section **111**, an object information generating section **120**, a captured image retaining section **115**, a sound input section **131**, a specific sound detecting section **132**, a manipulation receiving section **140**, and a timer setting section **150**. Further, the image capturing apparatus **100** includes a valid sound range setting section **160**, a selecting section **170**, a layer processing section **180**, a synthetic image retaining section **185**, a display control section **190**, a display section **191**, and a synthetic image storing section **200**. For example, the image capturing apparatus **100** can be realized by a digital video camera which can image an object to generate a captured image (image data), extract each characteristic amount for the image data by image analysis, and perform a variety of image processes using each of the extracted characteristic amounts. Further, the image capturing apparatus **100** is an example of image processing apparatuses disclosed in the claims.

The image capturing section **111** includes an image capturing element (for example, an image capturing element **112** shown in FIG. **19**) which transforms light of an object incident through a lens (not shown) into an electric signal, and a signal processing section (not shown) which processes an output signal of the image capturing element to generate a captured image (image data). That is, in the image capturing section **111**, an optical image of the object incident through the lens is formed on an imaging surface of the image capturing element, the image capturing element performs an image capturing operation in this state, and the signal processing section performs a signal process for the imaging signal, and thus, the captured image is generated. The captured image is generated on the basis of start instruction information of the image capturing operation output from the manipulation receiving section **140** or the timer setting section **150**. Further, the generated captured image is supplied to and retained in the captured image retaining section **115**. In addition, the generated captured image is supplied to the display control section **190** and then is displayed on the display section **191**. Further, the generated captured image, and the position and focusing position of each lens (for example, a focus lens and a zoom lens) at the time of generation of the captured image are supplied to the object information generating section **120**.

The captured image retaining section **115** is a ring buffer for retaining the captured image generated by the image capturing section **111** for a predetermined time, and supplies the retained captured image to the selecting section **170**. Further, the captured image retaining section **115** retains the object information generated by the object information generating section **120** in relation to the captured image generated by the image capturing section **111**. Here, the predetermined time when the captured image is retained in the captured image retaining section **115** can be 3 to 10 seconds, for example. That is, the latest captured image generated by the image capturing section **111** and the object information generated by the object information generating section **120** are retained for 3 to 10 seconds in the captured image retaining section **115**.

The object information generating section **120** generates object information relating to the captured image, on the basis of the captured image generated by the image capturing section **111** and each piece of information (for example, the position and focusing position of the lens) at the time of generation of the captured image. Further, the object information generating section **120** supplies the generated object information to the captured image retaining section **115** and allows it to be retained therein. The object information is information for discerning a target object region and a background region thereof from objects included in the captured image generated by the image capturing section **111**, for example. As the object information, for example, a depth map is generated. Here, the depth map is data indicating the distance (object distance) from an image capturing position (for example, a position of the image capturing apparatus **100**) to the object included in the captured image. As a technique of generating the depth map, for example, a technique such as TOF (time of flight), depth from defocus or the like may be used. For example, the TOF technique is a technique for calculating a distance to an object on the basis of the delay time during which light emitted from a light source is reflected from the object and reaches a sensor and the speed of the light.

The sound input section **131** obtains a sound around the image capturing apparatus **100**, and outputs the obtained sound (sound data) to the specific sound detecting section **132**. The sound input section **131** is realized by a plurality of microphones or the like, for example.

The specific sound detecting section **132** detects a specific sound on the basis of the sound output from the sound input section **131** and, in a case where the specific sound is detected, outputs this to the selecting section **170**. In the first embodiment of the present invention is exemplified a case where a sound (impact sound) generated at the moment that a golf club comes in contact with a golf ball during a golf swing is a specific sound. For example, the specific sound detecting section **132** stores a characteristic amount relating to a specific sound as specific sound identification information (reference data) in advance. Then, the specific sound detecting section **132** extracts the characteristic amount from the sound output from the sound input section **131** and compares the extracted characteristic amount and the specific sound identification information to calculate the similarity. In a case where the calculated similarity exceeds a threshold, the specific sound detecting section **132** determines that the sound output from the sound input section **131** is the specific sound. Specifically, the sound data output from the sound input section **131** is sampled by an AD (Analog to Digital) conversion process, and is converted into digital data. Further, a process such as a frequency analysis is performed for the digital data at an appropriate time interval, so that the digital data is converted into a parameter indicating a spectrum or other acoustic characteristics of the sound. Thus, the time-series characteristic amount for the sound is extracted. Further, a matching process with the extracted time-series characteristic amount is performed using the retained reference data, and then the sound recognition result is output as the result of the matching process. The sound analysis and recognition may be performed using various other existing methods.

The manipulation receiving section **140** receives manipulation contents manipulated by a user, and outputs a manipulation signal based on the received manipulation contents to the image capturing section **111**, the timer setting section **150**, the valid sound range setting section **160** and the display control section **190**. For example, when receiving a synthetic image recording mode setting manipulation which instructs setting of a synthetic image recording mode for generating the synthetic image, the manipulation receiving section **140** outputs a control signal for instructing a start of the image capturing operation to the image capturing section **111**. Then, the manipulation receiving section **140** outputs a control signal for instructing a display start of the captured image to the display control section **190**. The setting manipulation of the synthetic image recording mode is performed by a pressing manipulation of a setting button of the synthetic image recording mode, for example. Further, for example, when receiving a synthetic image recording mode release manipulation for instructing a release of the synthetic image recording mode, the manipulation receiving section **140** outputs a control signal for stopping the image capturing operation to the image capturing section **111**. The synthetic image recording mode release manipulation is performed by a release button of the synthetic image recording mode, for example. Further, for example, when receiving a recording instruction manipulation of the synthetic image in a case where the synthetic image recording mode is set, the manipulation receiving section **140** outputs a control signal indicating that the recording instruction manipulation of the synthetic image is received to the valid sound range setting section **160**. Then, the manipulation receiving section **140** outputs the control signal for stopping the image capturing operation to the image capturing section **111**. The recording instruction manipulation of the synthetic image is performed by a video recording button (REC button), for example. Further, for example, when receiving a timer setting manipulation for performing the image capturing operation in the synthetic image recording mode by a timer setting, the manipulation receiving section **140** outputs a control signal for instructing the timer setting to the timer setting section **150**. The timer setting manipulation is performed by a timer setting button, for example. Further, when the timer setting button is pressed, the setting manipulation of a counter value (for example, a setting of 8 to 17 seconds) may be performed. These manipulations may be input using a manipulation member such as buttons which are provided on the image capturing apparatus **100**, and may be performed by wireless communication through a remote controller manipulation or the like.

The timer setting section **150** sets a timer (for example, a self timer function) for performing the image capturing operation in the synthetic image recording mode. Specifically, if the timer setting manipulation is received by the manipulation receiving section **140**, the timer setting section **150** outputs the control signal for instructing the start of the image capturing operation to the image capturing section **111**. Further, the timer setting section **150** outputs the control signal for instructing the display start of the captured image and the count value due to the timer setting to the display control section **190**. In addition, after the display start of the count value, the timer setting section **150** sequentially outputs the count values according to the set contents to the display control section **190**. Thus, as shown in FIGS. **6**A and **6**B, the captured image generated by the image capturing section **111** is displayed on the display section **191**, and the count value is overlapped and displayed on the captured image. For example, a count value which is counted up one by one for every second is displayed on the display section **191**. Further, in a case where the count value of the set timer is “zero”, the timer setting section **150** outputs a control signal indicating the fact to the valid sound range setting section **160**. Further, the timer setting section **150** outputs the control signal for stopping the image capturing operation to the image capturing section **111**.

In a case where the synthetic image recording mode is set, the valid sound range setting section **160** sets a valid sound range for determining whether a specific sound detected by the specific sound detecting section **132** is valid or not. Further, the valid sound range setting section **160** outputs information about the set valid sound range (the valid sound range and the position in the time axis which serves as a reference at the time of setting the range) to the selecting section **170**. Specifically, in a case where the recording instruction manipulation of the synthetic image is received by the manipulation receiving section **140**, or in a case where the count value of the timer set by the timer setting section **150** becomes “zero”, the valid sound range setting section **160** sets the valid sound range. Here, in a case where the recording instruction manipulation of the synthetic image is received by the manipulation receiving section **140**, the position in the time axis in which the recording instruction manipulation of the synthetic image is received becomes the reference position. Further, the count value of the timer set by the timer setting section **150** becomes “zero”, the position in the time axis in which the count value becomes “zero” becomes the reference position. These setting methods of the valid sound range will be described in detail with reference to FIGS. **5**A to **7**C and so on.

The selecting section **170** selects synthesis target images used in the generation process of the synthetic image by means of the layer processing section **180**, from the captured images retained in the captured image retaining section **115**. Further, the selecting section **170** outputs information about the selected synthesis target images (for example, the synthesis target images, object information about these images, and coordinates used in the generation process of the synthetic image) to the layer processing section **180**. An internal configuration of the selecting section **170** will be described in detail with reference to FIG. **2**. Further, the synthesis target images are an example of motion transition images disclosed in the claims.

The layer processing section **180** generates the synthetic image using the synthesis target images selected by the selecting section **170** and then stores the generated synthetic image in the synthetic image storing section **200**. An internal configuration of the layer processing section **180** will be described in detail with reference to FIG. **2**. Further, the layer processing section **180** is an example of a synthetic image generating section disclosed in the claims.

The synthetic image retaining section **185** retains the synthetic image (history image) during the synthesis process at the time of the generation process of the synthetic image by means of the layer processing section **180**, and supplies the retained synthetic image to the layer processing section **180**. The synthetic image retaining section **185** will be described in detail with reference to FIG. **2**.

The display control section **190** displays the synthetic image stored in the synthetic image storing section **200** or the captured image output from the image capturing section **111** on the display section **191**, according to the manipulation input received by the manipulation receiving section **140**. Further, the display control section **190** overlaps the count value of the timer set by the timer setting section **150** with the captured image to be displayed on the display section **191**.

The display section **191** displays each image under the control of the display control section **190**.

The synthetic image storing section **200** stores the synthetic image generated by the layer processing section **180** and supplies the stored synthetic image to the display control section **190**.

FIG. **2** is a block diagram illustrating an example of a functional configuration of the selecting section **170** and the layer processing section **180** according to a second embodiment of the present invention. The selecting section **170** includes the synthesis target image selection range determining section **171**, the synthesis target image selecting section **172**, a coordinate calculating section **173**, and a counter section **174**. Further, the layer processing section **180** includes the layer separating section **181**, the layer modifying section **182** and a layer synthesizing section **183**.

The synthesis target image selection range determining section **171** determines a range (synthesis target image selection range) for selecting the synthesis target images used in the generation process of the synthetic image by means of the layer processing section **180**, among the captured images retained in the captured image retaining section **115**. Specifically, the synthesis target image selection range determining section **171** determines the synthesis target image selection range, on the basis of, the detection position (position in the time axis) of the specific sound detected by the specific sound detecting section **132** and the valid sound range set by the valid sound range setting section **160**. For example, the synthesis target image selection range determining section **171** determines the synthesis target image selection range on the basis of the detection position of the specific sound, in a case where the detection position of the specific sound is included in the valid sound range. On the other hand, the synthesis target image selection range determining section **171** determines the synthesis target image selection range on the basis of the position in the time axis which becomes the reference at the time of setting the valid sound range, in a case where the detection position of the specific sound is not included in the valid sound range. Here, in a case where the recording instruction manipulation of the synthetic image is received by the manipulation receiving section **140**, the position in the time axis in which the recording instruction manipulation of the synthetic image is received becomes the reference position. Further, in a case where the count value of the timer set by the timer setting section **150** becomes "zero", the position in the time axis in which the count value becomes "zero" becomes the reference position. Further, the synthesis target image selection range determining section **171** outputs the information about the determined synthesis target image selection range (for example, the synthesis target image selection range and object information about images included in this range) to the synthesis target image selecting section **172**. The synthesis target image selection range determining section **171** is an example of a determining section disclosed in the claims.

The synthesis target image selecting section **172** selects the synthesis target images used in the generation process of the synthetic image by means of the layer processing section **180** from the respective images included in the synthesis target image selection range determined by the synthesis target image selection range determining section **171**. For example, the synthesis target image selecting section **172** selects images at a predetermined time interval as the synthesis target images from the respective images (captured images retained in the captured image retaining section **115**) included in the synthesis target image selection range determined by the synthesis target image selection range determining section **171**. Further, for example, the synthesis target images may be selected to have an interval suitable for visualizing the motion transitions of the target object. Further, the synthesis target image selecting section **172** outputs the information about the selected synthesis target images (for example, the synthesis target images, object information about these images) to the coordinate calculating section **173** and the layer separating section **181**.

The coordinate calculating section **173** calculates coordinates used in the generation process of the synthetic image by the layer processing section **180**, with respect to each synthesis target image output from the synthesis target image selecting section **172**, and outputs the calculated coordinates to the layer modifying section **182**. In this coordinate calculation, a pixel position to be synthesized with the synthetic image relating to the synthesis target image which is the calculation target is calculated. That is, in this coordinate calculation, a pixel range (for example, a range including F**0** and F**10** shown in FIG. **8**D) is calculated corresponding to the synthesis target images which are the calculation target among a synthetic image which is finally generated (for example, a synthetic image **402** shown in FIG. **8**D).

The counter section **174** supplies a value of the counter (impact sound detection counter) used at the time of the synthesis target image selection range determination by the synthesis target image selection range determining section **171** to the synthesis target image selection range determining section **171**. Here, the counter section **174** continuously increases the impact sound detection counter. Further, in a case where the fact that the specific sound is detected from the specific sound detecting section **132** is output to the synthesis target image selection range determining section **171**, the value of the impact sound detection counter is reset to "zero" by the synthesis target image selection range determining section **171**. Similarly, after the reset, the counter section **174** also continuously increases the impact sound detection counter. Further, the synthesis target image selection range determining section **171** estimates the impact sound detection position using the value of the impact sound detection counter at the time of the determination of the synthesis target image selection range. That is, at the time of the determination of the synthesis target image selection range, a position (preceding position in the time axis) preceding by the value of impact sound detection counter than the determination time is estimated as the impact sound detection position.

The layer separating section **181** performs layer separation using corresponding object information, for the synthesis target images selected by the synthesis target image selecting section **172**. Here, the term "layer" refers to each image obtained by separating the target object section and the background section for one image (frame). Further, the layer separating section **181** outputs each separated layer image to the layer modifying section **182**.

The layer modifying section **182** performs a variety of modifying processes for generating the respective layer images output from the layer separating section **181** as the synthetic image, using the coordinates calculated by the coordinate calculating section **173**. As this modifying process, geometric arithmetic processes such as cutout, scaling, rotation and coordinate movement are performed. For example, the scaling has its process contents determined according to the number of synthesis target images, the size of the synthetic image, or the like. Further, as the modifying process, image processing such as emphasis on a motion portion of the target object may be performed. In addition, the layer modifying section **182** outputs the layer image which is processed to the layer synthesizing section **183**.

The layer synthesizing section **183** performs an image synthesis process for the layer image output from the layer modifying section **182**, and stores the generated synthetic image to the synthetic image storing section **200**. Specifically, the layer synthesizing section **183** synthesizes the respective layer images so that the layer image output from the layer modifying section **182** is arranged in a corresponding pixel range. Further, the layer synthesizing section **183** synthesizes the layer images which are immediately before the synthesis targets, and then sequentially retain the synthetic images (history images) in the synthetic image retaining section **185**. Further, when performing the synthesis process of the layer images which become the next synthesis target, the layer synthesizing section **183** obtains, from the synthetic image retaining section **185**, the synthetic images (history images) retained in the synthetic image retaining section **185**, and uses them in the synthesis process.

The synthetic image retaining section **185** sequentially retains the synthetic images (history images) generated by the layer synthesizing section **183**, and supplies the retained synthetic images to the layer synthesizing section **183**. That is, the synthetic images generated by the layer synthesizing section **183** are sequentially updated and retained in the synthetic image retaining section **185**.

[Example of Transitions of Synthetic Image Generation Process]

Next, an example of transitions of the generation process in a case where the synthetic image is generated will be briefly described.

FIGS. **3**A to **3**C are diagrams schematically illustrating the positional relation of the image capturing apparatus **100** and a person **300** who is the image capturing target and the relation of moving images generated in this positional relation, according to the first embodiment of the present invention.

FIG. **3**A schematically illustrates the positional relation between the image capturing apparatus **100** and the person **300** who is the image capturing target with respect to the image capturing apparatus **100**. The person **300**, for example, has a practice swing of a golf club **301** in a golf practice range. As the person **300** swings the golf club **301** from a posture shown in FIG. **3**A, the person **300** hits the golf ball **302** with the golf club **301** to drive the golf ball **302** in a desired direction.

FIG. **3**B schematically illustrates a moving image **310** generated by the image capturing section **111** in a rectangular shape. Further, in FIG. **3**B, in the rectangular shape corresponding to the moving image **310**, some frames (images **311** to **313** and the like) among frames for forming the moving image **310** are arranged along a time axis. Further, the moving image **310** is a moving image obtained by imaging the appearance of the golf practice swing of the person **300** by the image capturing apparatus **100** in a state shown in FIG. **3**A. Here, the image **311** is an image obtained by imaging a state where the person **300** is ready for the golf swing, and the image **312** is an image obtained by imaging a state where the person **300** views a direction where the golf ball **302** flies after the golf swing is finished. Further, the image **313** is an image obtained by imaging a state of the moment when the golf club **301** comes in contact with the golf ball **302** when the person **300** performs a golf swing. Here, when the person **300** performs the golf swing, a specific sound (impact sound) is generated at the moment when the golf club **301** comes in contact with the golf ball **302**. The position in the moving image **310** in which the impact sound is generated is represented as an impact sound generation position **315**.

In a case where the synthetic image indicating the transitions of the golf swing of the person **300** is generated using the moving image **310** thus generated, for example, a predetermined range (synthesis target image selection range) for selecting the synthesis target images is selected. The synthesis target image selection range is a range in which a series of motion transitions, for example, from the start of the golf swing to the end thereof is included. Further, in the predetermined range, the images which are the synthesis targets are selected and synthesized. This synthesis example is shown in FIG. **4**B.

For example, as shown in FIG. **3**B, a synthesis target image selection range **320** is determined in the moving image **310**, and frames which satisfy a predetermined condition are determined as the synthesis target images, among respective frames included in the synthesis target image selection range **320**.

In FIG. **3**C, some frames (images **321** to **326**) among the respective frames included in the synthesis target image selection range **320** determined in the moving image **310** shown in FIG. **3**B are arranged along the time axis. Here, the moving image **321** is an image captured when the person **300** starts the golf swing, and the image **326** is an image captured when the person **300** finishes the golf swing. Further, the image **323** is an image corresponding to the image **313** shown in FIG. **3**B. In addition, the images **322**, **324** and **325** are images obtained by sequentially imaging the motion transitions of the person **300** who performs the golf swing in a time-series manner, between the images **321** and **326**.

FIGS. **4**A and **4**B are diagrams illustrating an example of the synthesis target images selected by the synthesis target image selecting section **172** and the synthetic image generated by a layer processing section **180**, according to the first embodiment of the present invention. In FIG. **4**A, **24** images selected as the synthesis target images among the respective frames included in the synthesis target image selection range **320** in the moving image **310** shown in FIG. **3**B are arranged in a time-series manner. Images including the same object as the images **321** to **326** shown in FIG. **3**C among the **24** images shown in FIG. **4**A are given the same reference numbers. Here, as the selection method of the synthesis target images, for example, a selection method for selecting frames at a predetermined interval as the synthesis target images may be used. Further, for example, it may be considered that the motion transitions around the time when the golf ball **301** comes in contact with the golf ball **302** are minutely confirmed in some cases. In this case, an interval of the neighboring images of the image (for example, the image **323**) when the impact sound is generated may be closer than other intervals to select the synthesis target images.

FIG. **4**B schematically illustrates the synthetic image **330** generated by the layer processing section **180**. In this way, the synthesis target image selection range in which the motion transitions from the start of the golf swing of the person **300** to the end thereof are included is determined and the synthesis target images are selected in the synthesis target image selection range for synthesis. Thus, the synthetic image indicating the motion transitions of the golf swing of the person **300** can be generated.

As described above, in a case where the synthetic image is generated from the moving image **310**, it is important to appropriately select the synthesis target image selection range for selection of the synthesis target images. However, since the golf swing is performed in a relatively short time, it may be difficult to appropriately select the synthesis target image selection range from the moving image **310**. That is, it may be difficult to select the synthesis target image selection range from the moving image **310** including images ranging from an image including a state before the start of the golf swing of the person **300** to an image including a state after the end of the golf swing.

Here, as described above, the impact sound is generated in the middle of the golf swing. In this way, since the impact sound is frequently generated in a predetermined position during the golf swing, the synthesis target image selection range may be selected on the basis of the impact sound. However, in a case where the person **300** practices at a golf practice range where there are a lot of other people, it is highly likely that the impact sound is generated by the golf swing of a person other than the person **300** as the person **300** gets ready for a golf swing or the like. That is, in a case where an instant motion relating to sport causing the impact sound is appropriately recorded, if the detected impact sound is always valid, it is highly likely to mistakenly detect an impact sound from a person other than a detection target. For this reason, in a case where the synthetic image relating to the person **300** is generated, it is important to appropriately detect the impact sound generated by the golf swing of the person **300** when the synthesis target image selection range is selected on the basis of the impact sound. Thus, in the first embodiment of the present invention, an example that a valid sound range is provided in which only adjacent timing around a photographing trigger based on the user manipulation is valid is set to reduce the false detection of the impact sound. The synthesis target image selection range is set using only the impact sound detected in the valid sound range, to thereby select appropriate synthesis target images.

[Determination Example of Synthesis Target Image Selection Range Based on Video Recording Button Manipulation]

FIGS. **5**A, **5**B and **5**C are diagrams schematically illustrating a setting method of a valid sound range by the valid sound range setting section **160** and a determination method of a synthesis target image selection range by the synthesis target image selection range determining section **171**, according to the first embodiment of the present invention.

FIG. **5**A schematically illustrates a moving image **350** generated by the image capturing section **111** in a rectangular shape. Further, in a similar way to the example shown in FIG. **3**B, the moving image **350** is a moving image obtained by imaging the appearance of a golf practice swing of a person (for example, Koda Goro) by the image capturing apparatus **100**. Here, it is assumed that Koda Goro asks his friend (for example, Otogawa Rokuro) to photograph his golf swing. In this case, Otogawa Rokuro holds the image capturing apparatus **100** with his hands with an optical axis direction thereof being toward Koda Goro, and presses a setting button of a synthetic image recording mode. If the press manipulation is received by the manipulation receiving section **140**, captured images are generated by the image capturing section **111**, and the generated captured images are sequentially retained in the imaging image retaining section **115**. Further, the display control section **190** sequentially displays the generated captured images (so-called through images) on the display section **191**. In this way, in a state where Otogawa Rokuro performs photographing using the image capturing apparatus **100** in which the synthetic image recording mode is set, Koda Goro performs a golf swing. Right after Koda Goro finishes the golf swing, Otogawa Rokuro rapidly presses the video recording button. If the press manipulation is received by the manipulation receiving section **140**, the valid sound range setting section **160** sets the valid sound range.

For example, it is assumed that a position (position in the time axis) where the video recording button is pressed by Otogawa Rokuro is a press position (video recording button press position **351**) of the video recording button in the time axis of the moving image **350** shown in FIG. **5**A. In this case, the valid sound range setting section **160** sets a valid sound range **352** on the basis of the video recording button press position **351**. Specifically, the valid sound range setting section **160** sets a range which precedes the video recording button press position **351** by a time L**1** in the time axis, as the valid sound range **352**. In this example, since the pressing (photographing trigger) of the video recording button may be generated after the end of a series of golf swing motions, the generation position of the impact sound may exist before the timing of the photographing trigger. Accordingly, this example is an example in which the valid sound range is set before the pressing of the video recording button.

Here, the time L**1** can be 1.0 second, for example. The synthesis target image selection range is determined on the basis of the impact sound detected in the valid sound range set in this way. The determination method of the synthesis target image selection range will be described with reference to FIG. **5**B. Further, in a case where the impact sound is not detected in the valid sound range set in this way, the synthesis target image selection range is determined on the basis of the video recording button press position **351**. The determination method of the synthesis target image selection range will be described with reference to FIG. **5**C.

FIG. **5**B schematically illustrates a determination method of the synthesis target image selection range in a case where the impact sound is detected in the valid sound range **352** set by the valid sound range setting section **160**. In FIG. **5**B, the position (position in the time axis) where the impact sound is detected by the specific sound detecting section **132** is represented as an impact sound detection position **353**. As shown in FIG. **5**B, in the case where the impact sound is detected in the valid sound range **352** set by the valid sound range setting section **160**, the synthesis target image selection range determining section **171** determines the synthesis target image selection range on the basis of the impact sound detection position **353**. That is, the synthesis target image selection range determining section **171** determines a predetermined range before and after the impact sound detection position **353** in the time axis with reference to the impact sound detection position **353**, as the synthesis target image selection range **354**. Specifically, the synthesis target image selection range determining section **171** determines a range L**4**, which includes a range which precedes the impact sound detection position **353** by a time L**2** and a range which exceeds the impact sound detection position **353** by a time L**3**, in the time axis, as a synthesis target image selection range **354**.

Here, in consideration of the rotation speed of the golf club, the time during a golf swing after the golf club comes in contact with the golf ball is shorter than the time before the golf club comes in contact with the golf ball. That is, the time during a golf swing after the impact sound is generated is shorter than the time before the impact sound is generated. Thus, the synthesis target image selection range **354** is determined so that the time L**2** before the impact sound detection position **353** is longer than the time L**3** thereafter. For example, the time L**2** can be 1.5 seconds and the time L**3** can be 0.5 seconds. In this way, as the synthesis target image selection range is determined on the basis of the impact sound detected in the valid sound range, an appropriate synthesis target image selection range can be determined.

Here, it is assumed that an impact sound is detected in positions (for example, positions indicated by arrows **358** and **359** shown in FIG. **5**B) other than the valid sound range **352** set by the valid sound range setting section **160**. In a case where the impact sound is detected in the positions other than the valid sound range **352**, the impact sound is not used for determination of the synthesis target image selection range. In a case where the impact sound is not used, as shown in FIG. **5**C, the synthesis target image selection range can be determined on the basis of the press position of the video recording button. Further, in a case where the impact sound is detected in the positions other than the valid sound range **352**, the impact sound is not used for determination of the synthesis target image selection range, but may be used for the generation process of the next synthetic image.

FIG. **5**C schematically illustrates a determination method of the synthesis target image selection range in a case where the impact sound is not detected in the valid sound range **352** set by the valid sound range setting section **160**. In FIG. **5**C, in a similar way to the case of FIG. **5**A, a position where the video recording button is pressed is represented as the video recording button press position **351**. As shown in FIG. **5**C, in a case where the impact sound is not detected in the valid sound range **352**, the synthesis target image selection range determining section **171** determines the synthesis target image selection range on the basis of the video recording button press position **351**. That is, the synthesis target image selection range determining section **171** determines a predetermined range before the video recording button press position **351** in the time axis with reference to the video recording button press position **351**, as a synthesis target image selection range **355**. Specifically, the synthesis target image selection range determining section **171** determines a range which precedes the impact sound detection position **353** by a time L**7** (L**5**+L**6**) in the time axis, as the synthesis target image selection range **355**. In this way, in a case where the impact sound is not detected in the valid sound range **352**, a position, which precedes the press position of the video recording button by a time L**6** in the time axis, is considered as the impact sound detection position to determine the synthesis target image selection range **355**. That is, the times L**5** and L**6** correspond to the times L**2** and L**3** shown in FIG. **5**B. Here, for example, in a similar way to the case of FIG. **5**B, the time L**7** can be 2.0 seconds. That is, the time L**5** is 1.5 seconds and the time L**6** is 0.5 seconds. However, in a case where the synthesis target image selection range is determined on the basis of the video recording button press position, since the synthesis target image selection range is determined on the basis of the user manipulation, accuracy may be decreased compared with the synthesis target image selection range **354** shown in FIG. **5**B. Thus, in a case where the synthesis target image selection range is determined on the basis of the video recording button press position, for example, the time L**7** may be longer than the time L**4** to determine the synthesis target image selection range.

Further, these times L**1** to L**7** may be changed by the user manipulation.

[Determination Example of Synthesis Target Image Selection Range Based on Timer]

FIGS. **6**A and **6**B are diagrams illustrating an example of transitions of a display screen displayed on the display section **191** according to the first embodiment of the present invention. FIG. **6**A illustrates a display example (display screen **370**) in which a count value "17" (**372**) of a timer set by the timer setting section **150** is overlapped with an image generated by the image capturing section **111** before the start of the golf swing of the person **300**. FIG. **6**B illustrates a display example (display screen **371**) in which a count value "0" (**373**) of the timer set by the timer setting section **150** is overlapped with an image generated by the image capturing section **111** at the end of the golf swing of the person **300**.

In this example, it is assumed that the person **300** (for example, Koda Goro) photographs his appearance of golf practice swing by himself. In this case, for example, Koda Goro who is practicing installs the image capturing apparatus **100** so that the optical axis direction thereof is directed toward himself, as shown in FIG. **3**A, and then presses a timer setting button. Through this press manipulation, captured images are generated by the image capturing section **111**, and the display control section **190** displays the generated captured images (so-called through images) on the display section **191**. Further, the timer setting section **150** sets the timer through the press manipulation of the timer setting button, and the display control section **190** overlaps the count value (for example, 17 seconds) corresponding to the set contents with the through images to be displayed on the display section **191**. For example, as shown in FIG. **6**A, after the press of the timer setting button, the display screen **370** is displayed in which the count value "17" (**372**) of the timer set by the timer setting section **150** is overlapped with the captured image including the person **300** who is ready for the golf swing. Thereafter, similarly, a display screen in which the count values (for example, values decreased from 17 seconds at intervals of one second) of the timer are overlapped with the captured image including the person **300** is displayed on the display section **191**. The person **300** performs the golf swing so that the golf swing is terminated around the time when the count value of the timer becomes "0" while viewing the display screen displayed on the display section **191** in this way. Further, in a case where the count value of the timer is "0", the valid sound range setting section **160** sets the valid sound range. Then, the imaging motion is stopped after a predetermined time. The setting method of the valid sound range will be described in detail with reference to FIGS. **7**A, **7**B and **7**C.

As the timer setting is performed as described above, for example, even in a case where a friend does not perform photographing, the person **300** can easily photograph the appearance of the golf swing of his own.

FIGS. **7**A, **7**B and **7**C are diagrams schematically illustrating a setting method of a valid sound range by the valid sound range setting section **160** and a determination method of the synthesis target image selection range by the synthesis target image selection range determining section **171**, according to the first embodiment of the present invention. Here, the first embodiment provides an example in which the valid sound range is set on the basis of the timer set by the timer setting section **150**.

FIG. **7**A schematically illustrates a moving image **380** generated by the image capturing section **111** in a rectangular shape. In a similar way to the example shown in FIG. **3**B, the moving image **380** is a moving image obtained by imaging the appearance of a golf practice swing of a person (for example, Koda Goro) by the image capturing apparatus **100**. For example, as shown in FIGS. **6**A and **6**B, in a case where the person **300** (for example, Koda Goro) photographs his appearance of golf practice swing by himself, it is assumed that the count value of the timer set by the timer setting section **150** is "0". In this case, as described above, the valid sound range setting section **160** sets the valid sound range.

For example, it is assumed that a position in which the count value of the timer set by the timer setting section **150** is "0" is a position of the time counter "0" in the time axis of the moving image **380** shown in FIG. **7**A (time counter "0" position **381**). In this case, the valid sound range setting section **160** sets the valid sound range **382** on the basis of the time counter "0" position **381**. Specifically, the valid sound range setting section **160** sets a predetermined range before and after the time counter "0" position **381** in the time axis with reference to the time counter "0" position **381**, as the valid sound range **382**. For example, the valid sound range setting section **160** sets a range L**13**, which includes a range which precedes the time counter "0" position **381** by a time L**11** and a range which exceeds the time counter "0" position **381** by a time L**12**, in the time axis, as the valid sound range **382**.

Here, it may be difficult for the person **300** to perform the golf swing so as to terminate the series of golf swing motions at the timing of the time counter "0". Thus, in this example, the instant when the impact sound is generated may correspond to the position of the time counter "0", and the valid sound range is set to cover a range before and after the position of the time counter "0". In this way, a case where the valid sound range is set on the basis of the press position of the video recording button and a case where the valid sound range is set on the basis of the position of the time counter "0" can have different set contents. As the valid sound range is set according to a plurality of photographing trigger characteristics, it is possible to reduce the risk that sounds other than the impact sound to be detected are mistakenly detected.

In this respect, the time L**11** can be 0.5 seconds and the time L**12** can be 0.5 seconds, for example. That is, the time L**13** of the valid sound range **382** can be 1.0 second, for example. The person **300** performs the golf swing so that the golf swing is terminated around the time when the count value of the timer becomes "0" while viewing the display screen displayed on the display section **191**. For this reason, compared with the case where the valid sound range is set on the basis of the position where the video recording button is pressed, accuracy may be reduced. Accordingly, the valid sound range based on the timer setting manipulation may be relatively wider than the valid sound range based on the video recording button press manipulation. That is, the valid sound range based on the video recording button press manipulation may be narrower than the valid sound range based on the timer setting manipulation. The synthesis target image selection range is determined on the basis of the impact sound detected in the valid sound range set in this way. The determination method of the synthesis target image selection range will be described with reference to FIG. **7**B. Further, in a case where the impact sound is not detected in the valid sound range set in this way, the synthesis target image selection range is determined on the basis of the time counter "0" position **381**. The determination method of the synthesis target image selection range will be described with reference to FIG. **7**C.

FIG. **7**B schematically illustrates the determination method of the synthesis target image selection range in a case where the impact sound is detected in the valid sound range **382** set by the valid sound range setting section **160**. In FIG. **7**B, a position (position in the time axis) in which the impact sound is detected by the specific sound detecting section **132** is represented as the impact sound detection position **383**. As shown in FIG. **7**B, in a case where the impact sound is detected in the valid sound range **382** set by the valid sound range setting section **160**, the synthesis target image selection range determining section **171** determines the synthesis target image selection range on the basis of the impact sound detection position **383**. That is, the synthesis target image selection range determining section **171** determines a predetermined range before and after the impact sound detection position **383** in the time axis with reference to the impact sound detection position **383**, as the synthetic target image selection range **384**. Specifically, a range L**16**, which includes a range which precedes the impact sound detection position **383** by a time L**14** and a range which exceeds the impact sound detection position **383** by a time L**15**, in the time axis, is determined as the synthetic target image selection range **384**.

Here, as described above, the time during a golf swing after the golf club comes in contact with the golf ball is shorter than the time before the golf club comes in contact with the golf ball. Thus, the synthesis target image selection range **384** is determined so that the time L**14** before the impact sound detection position **383** is longer than the time L**15** thereafter. For example, the time L**14** can be 1.5 seconds and the time L**15** can be 0.5 seconds. In this way, as the synthesis target image selection range is determined on the basis of the impact sound detected in the valid sound range, an appropriate synthesis target image selection range can be determined.

It is assumed that the impact sound is detected in positions (for example, positions indicated by arrows **388** and **389** in FIG. **7**B) other than the valid sound range **382** set by the valid sound range setting section **160**. In a case where the impact sound is detected in the positions other than the valid sound range **382** in this way, the impact sound is not used for determination of the synthesis target image selection range, in a similar way to the example shown in FIG. **5**B. In a case where the impact sound is not used, as shown in FIG. **7**C, the synthesis target image selection range can be determined on the basis of the time counter "0" position. Further, in a case where the impact sound is detected in the positions other than the valid sound range **382**, the impact sound is not used for determination of the synthesis target image selection range, but may be used for a generation process of the next synthetic image.

FIG. **7**C schematically illustrates the determination method of the synthesis target image selection range in a case where the impact sound is not detected in the valid sound range **382** set by the valid sound range setting section **160**. In FIG. **7**C, the position in which the count value of the timer set by the timer setting section **150** is "0" is represented as the time counter "0" position **381**, in a similar way to the example of FIG. **7**A. As shown in FIG. **7**C, in a case where the impact sound is not detected in the valid sound range **382**, the synthesis target image selection range determining section **171** determines the synthesis target image selection range on the basis of the time counter "0" position **381**. That is, the synthesis target image selection range determining section **171** determines a predetermined range before and after the time counter "0" position **381** in the time axis with reference to the time counter "0" position **381**, as a synthesis target image selection range **385**. Specifically, the valid sound range setting section **160** sets a range L**19**, which includes a range which precedes the time counter "0" position **381** by a time L**17** and a range which exceeds the time counter "0" position **381** by a time L**18**, in the time axis, as the synthesis target image selection range **385**.

Here, the person **300** performs the golf swing so that the golf swing is terminated around the time when the count value of the timer becomes "0" while viewing the display screen displayed on the display section **191**. For this reason, as shown in FIG. **5**C, compared with the case where the synthesis target image selection range is determined on the basis of the position where the video recording button is pressed, accuracy may be reduced. Accordingly, in a case where the impact sound is not detected in the valid sound range **382**, a position where the count value of the timer is "0" (timer counter "0" position **381**) in the time axis is considered as the impact sound detection position to determine the synthesis target image selection range **385**.

Further, the times L**17** and L**18** correspond to the times L**14** and L**15** shown in FIG. **7**B. Further, for example, the time L**17** is 1.5 seconds and the time L**18** is 0.5 seconds, in a similar way to the example of FIG. **7**B. As described above, in a case where the synthesis target image selection range is determined on the basis of the position where the count value of the timer is "0", the synthesis target image selection range is determined on the basis of an action due to a sense of the user. For this reason, accuracy may be reduced, compared with the synthesis target image selection range **384** shown in FIG. **7**B. Thus, in a case where the synthesis target image selection range is determined on the basis of the position where the count value of the timer is "0", for example, the time L**19** may be longer than the time L**16** to determine the synthesis target image selection range.

Further, the respective times L**11** to L**19** may be changed by the user manipulation.

[Generation Example of Synthetic Image]

Next, an example of generating a synthetic image will be described in detail with reference to the drawings, using each frame included in the determined synthesis target image selection range. In the first embodiment of the present invention, a case where a synthetic image of a still image is generated will be described as an example.

FIGS. **8**A, **8**B, **8**C and **8**D are diagrams schematically illustrating an example of a flow of a selection process of synthesis target images by the selecting section **170** and a generation process of a synthetic image by the layer processing section **180**, according to the first embodiment of the present invention.

FIG. **8**A schematically illustrates a moving image **400** generated by the image capturing section **111** and a synthesis target image selection range **401** determined by the synthesis target image selection range determining section **171** in the moving image **400**. The moving image **400** is a moving image obtained by imaging the appearance of a golf practice swing of a person by the image capturing apparatus **100**, in a similar way to the example shown in FIG. **3**B or the like. Further, it is assumed that the synthesis target image selection range **401** is a synthesis target image selection range determined by the synthesis target image selection range determining section **171**, in a similar way to the examples shown in FIGS. **5**B and **5**C and FIGS. **7**B and **7**C.

FIG. **8**B schematically illustrates respective frames included in the synthesis target image selection range **401** in the moving image **400**. In FIG. **8**B, the respective frames included in the synthesis target image selection range **401** are shown in a rectangular shape. Here, F**1** to F**90** indicating the respective frames are given in the rectangular shape.

The synthesis target image selecting section **172** selects synthesis target images on the basis of a predetermined condition, from the respective frames included in the synthesis target image selection range **401**. For example, the synthesis target image selecting section **172** selects frames at a predetermined interval (for example, 10-frame interval) among the frames F**1** to F**90**, as the synthesis target images. In this case, for example, intervals of frames included in a predetermined range (for example, 0.05 seconds) around a position where the impact sound is detected may be closer than other intervals, to be selected. Accordingly, the synthetic image can be generated using the images selected around motion transitions to be observed. The synthesis target images selected in this way are shown in FIG. **8**C. In this example, for simplicity of the description, a relatively small number of frames are exemplified.

FIG. **8**C schematically illustrates a plurality of synthesis target images (frames F**0**, F**10** and the like) selected as the synthesis target image, from the respective frames included in the synthesis target image selection range **401**. In FIG. **8**C, the synthesis target images are shown in a rectangular shape. Here, F**0**, F**10** or the like indicating each synthesis target image is given in the rectangular shape. In this example, for simplicity of the description, a relatively small number of frames (for example, 10 frames) are exemplified.

FIG. **8**D schematically illustrates a synthetic image **402** generated by the synthesis target images (the plurality of frames F**0**, F**10** and the like). In FIG. **8**D, the synthesis target images are shown in a rectangular shape, in a similar way to the example of FIG. **8**C. Here, F**1**, F**10** or the like indicating each synthesis target image is given in the rectangular shape.

The layer processing section **180** synthesizes the synthesis target images (frames F**0**, F**10** and the like) selected by the synthesis target image selecting section **172** through a modifying process, to thereby generate a synthetic image. For example, the layer processing section **180** performs the modifying process (for example, cutout of opposite ends) for synthesis with respect to ten synthesis target images selected by the synthesis target image selection range determining section **171**, to thereby synthesize the synthesis target images after modification in a time-series manner. For example, the layer processing section **180** synthesizes five synthesis target images (F**0**, F**10**, F**20**, F**30** and F**40**) to be arranged in a time-series manner from an upper left end part, and synthesis five synthesis target images (F**50**, F**60**, F**70**, F**80** and F**90**) to be arranged in a time-series manner from a lower left end part. The synthesis positions of the synthesis target images are determined on the basis of the calculation result by the coordinate calculating section **173**. Accordingly, as shown in FIG. **4**B, the synthetic image indicating the motion transitions of the person who practices the golf swing is generated.

In FIGS. **8**A, **8**B, **8**C and **8**D, the example in which the image synthesis is easily performed (example in which the image synthesis is performed after the cutout of the opposite ends of the synthesis target image) has been described. Hereinafter, an example in which the synthesis target images are separated into a target object layer and a background layer to generate a synthetic image will be described.

[Layer Separation Example of Synthesis Target Images]

FIGS. **9**A and **9**B are diagrams schematically illustrating a separation method of synthesis target images by the layer separating section **181** according to the first embodiment of the present invention. In this example, the synthesis target images selected by the synthesis target image selecting section **172** are separated into two layers on the basis of the object information generated by the object information generating section **120**.

FIG. **9**A illustrates the synthesis target image **410** and an object information **412** generated for the synthesis target image **410**. The synthesis target image **410** is an image including a person **411**. Further, as the object information generated by the object information generating section **120**, for example, information indicating that "1" is given to pixels corresponding to a target object region and "0" is given to pixels corresponding to a region (for example, background region) other than the target object is generated. In FIG. **9**A, a region (target object region) corresponding to the person **411** is a white region **413** and the region (background region) other than the person **411** is a black region, to thereby schematically illustrate the object information **412**.

As described above, in the captured image retaining section **115**, the captured images generated by the image capturing section **111** are sequentially retained, and the object information generated by the object information generating section **120** is retained in relation to the captured images. Further, the synthesis target image selecting section **172** outputs the selected synthesis target images and the object information generated for the synthesis target images to the layer separating section **181**. Then, the layer separating section **181** separates the synthesis target images output from the synthesis target image selecting section **172** into two layers, using the corresponding object information.

FIG. **9**B illustrates a target object layer **420** separated by the layer separating section **181** and a background layer **422**. The target object layer **420** is an image obtained by extracting the target object region (that is, a pixel region which is given "1" as the object information **412**) in the synthesis target image **410** shown in FIG. **9**A. That is, a region **421** corresponding to the person **411** included in the synthesis target image **410** is extracted. Further, the background layer **422** is an image obtained by extracting the background region (that is, a pixel region which is given "0" as the object information **412**) in the synthesis target image **410** shown in FIG. **9**A. That is, a region is extracted (region other than a region **423**) corresponding to the region (background region) other than the person **411** included in the synthesis target image **410**.

A variety of modifying processes is performed by the layer modifying section **182**, for the respective layer images separated in this way. This modification example will be described in detail with reference to FIGS. **10**A to **10**C.

[Modification Example of Synthesis Target Images]

FIGS. **10**A, **10**B and **10**C are diagrams schematically illustrating an image which is a target of a modification process by the layer modifying section **182** and an image which is modified by the layer modifying apparatus **182**, according to the first embodiment of the present invention. Here, a case where a synthetic image is generated for sport performed in a standing posture such as golf will be described as an example. Further, in FIGS. **10**A, **10**B and **10**C, for simplicity of the description, a case where the modifying process is performed using a synthesis target image of a state before layer separation is shown as an example.

FIG. **10**A illustrates a synthesis target image **430** before modification by means of the layer modifying section **182**. Further, FIGS. **10**B and **10**C illustrate synthesis target images **432** and **433** after modification by means of the layer modifying section **182**. A person **431** who performs the golf swing is included in the synthesis target images **430**, **432** and **433**.

The synthesis target image **430** shown in FIG. **10**A has an image size of a width W**1** and a height H**1**, for example. For example, the image size of the synthesis target image **430** can be the VGA size (640 pixels×480 pixels). That is, the width W**1** can be 640, and the height H**1** can be 480.

The synthesis target image **432** shown in FIG. **10**B is an image corresponding to a transition motion valid region in the synthesis target image **430** shown in FIG. **10**A, and for example, has an image size of a width W**2** and a height H**2**. Here, the transition motion valid region is a region for cutting out the target object from objects included in the synthesis target image before modification. For example, the image size of the synthesis target image **432** can be 320 pixels×480 pixels. That is, the width W**2** can be 320, and the height H**2** can be 480.

The synthesis target image **433** shown in FIG. **10**C is an image corresponding to a remaining background region in the synthesis target image **430** shown in FIG. **10**A, and for example, has an image size of a width W**3** and a height H**3**. The remaining background region is a region which is used as a background image in the synthesis process. For example, the image size of the synthesis target image **433** can be 160 pixels×480 pixels. That is, the width W**3** can be 160, and the height H**3** can be 480.

It is assumed that a central position between the transition motion valid region and the remaining background region coincides with a central position of the synthesis target image. Further, the size (W**2**×H**2**) of the transition motion valid region and the size (W**3**×H**3**) of the remaining background region may be the same in their sizes (at least one of the width and height) according to the transition direction of the target object. For example, the transition direction of the target object is a direction in which the images proceed in a temporal manner when the images are represented as motion transition images.

For example, in a case where a synthetic image is generated for motion transitions of sport performed in a standing posture such as golf, as shown in FIG. **4**B, it is likely that each target object image is transited in a transverse direction. For this reason, as shown in FIGS. **10**B and **10**C, it may be preferable that the heights H**2** and H**3** of the transition motion valid region and the remaining background region are the same as the height H**1** of the synthesis target image. On the other hand, in a case where a synthetic image is generated for motion transitions of sport performed in a horizontal direction state, each target object image may be transited in a longitudinal direction. In this case, it may be preferable that the widths W**2** and W**3** of the transition motion valid region and the remaining background region are the same as the width W**1** of the synthesis target image. For example, in a case where ground work or the like in judo becomes a target object, it is likely that the motion transitions are performed in a longitudinal direction.

FIGS. **10**A, **10**B and **10**C shows an example, in which it is preferable to perform appropriate setting for the width and the height of the transition motion valid region and the remaining background region according to the size or motion of the object, so as to cut out the image as an image used for the synthesis process.

[Image Synthesis Example]

FIGS. **11**A and **11**B are diagrams schematically illustrating a synthesis method by the layer synthesizing section **183** according to the first embodiment of the present invention. Here, this embodiment provides an example in which a synthesis process is performed for two synthesis target images which continues in a time-series manner.

FIG. **11**A schematically illustrates synthesis target images (two synthesis target images which continue in a time-series manner) separated by the layer separating section **181** and modified by the layer modifying section **182**. As described above, the synthesis target images are separated into a target object layer and a background layer by the layer separating section **181**. Further, the layer modifying section **182** performs a modification process for the target object layer and the background layer separated by the layer separating section **181**. In this way, as the separation and modification are performed for two synthesis target images which continue in a time-series manner, as shown in FIG. **11**A, four layers (a first priority image **441** to a fourth priority image **444**) are generated.

It is assumed that the first priority image **441** is a target object layer of a synthesis target image which comes later in the time axis, and the third priority image **443** is a background layer of the synthesis target image. Further, it is assumed that the second priority image **442** is a target object layer of a synthesis target image which comes earlier in the time axis, and the fourth priority image **444** is a background layer of the synthesis target image. Furthermore, in a case where these images are synthesized, the synthesis is performed so that an image having a higher priority is overwritten.

FIG. **11**B illustrates a synthetic image **450** generated on the basis of the priority of the respective layer images. That is, the layer synthesizing section **183** synthesizes four layers (the first priority image **441** to the fourth priority image **444**) on the basis of the priority, to thereby generate the synthetic image **450**. The synthetic image **450** is an image obtained by synthesizing a person image **445** included in the first priority image **441** and a person image **446** included in the second priority image **442** to be overwritten on the background region synthesized by the third priority image **443** and the fourth priority image **444**. In this case, the third priority image **443** is synthesized to be overwritten on the fourth priority image **444**. Further, the person image **445** included in the first priority image is synthesized to be overwritten on the person image **446** included in the second priority image **442**.

As shown in FIGS. **12**A and **12**B, in a case where three or more synthesis target images are sequentially synthesized to generate a synthetic image, the synthesis target images are sequentially synthesized in a time-series manner, to thereby generate the synthetic image. Further, a synthesis target image which comes earlier in the time axis among two synthesis target images which continue in a time-series manner is retained in the synthetic image retaining section **185**, until a synthesis process time of a synthesis target image which comes later.

FIGS. **12**A and **12**B are diagrams schematically illustrating a synthesis method of synthesis target images by means of the layer synthesizing section **183** according to the first embodiment of the present invention. Here, a synthesis example of the synthesis target images until a synthetic image **460** shown in FIG. **12**B is generated is shown.

FIG. **12**A illustrates a synthesis state at a certain time point until the synthetic image **460** shown in FIG. **12**B is generated. For example, it is assumed that the state shown in FIG. **12**A is a state at a time point when the synthesis process is performed for a synthesis target image **462** (two layer images). That is, FIG. **12**A shows a transition motion valid region E**10** corresponding to the synthetic target image **462**, and a synthetic image **461** in which the synthesis process is performed for a synthesis target image **463** which comes right before. In this example, the respective layer images which become the synthesis targets right before are retained in the synthetic image retaining section **185**.

Here, in a region E**11** in the synthesis target image **462**, there is no overlapped region between the adjacent synthesis target image **463** and the synthesis target image **462**. For this reason, in a case where the synthesis target image **462** is synthesized with the synthetic image **461**, with respect to the region E**11** in the synthesis target image **462**, pixels of the transition motion valid region of the synthesis target image **462** are synthesized to be overwritten on the synthetic image **461** as a new synthetic image as they are.

However, a region E**12** in the synthesis target image **462** is overlapped with a part of the adjacent synthesis target image **463**. Thus, as shown in FIGS. **11**A and **11**B, the respective layer images are synthesized in the region E**12** in the synthesis target image **462** according to the priority.

That is, the layer synthesizing section **183** synthesizes the respective layer images according to the priority for the region E**12**, using the respective layer images of the synthesis target image **462** which is a current synthesis target and the adjacent synthesis target image **463** retained in the synthetic image retaining section **185**. Through such a synthesis, a synthetic image of a region E**11**+E**12** is generated from the synthesis target images **462** and **463**. Further, the layer synthesizing section **183** synthesizes the synthetic image of the region E**11**+E**12** generated in this way to be overwritten, with the synthetic image (synthetic image synthesized with the adjacent synthesis target image **463**) retained in the synthetic image retaining section **185**. That is, the layer synthesizing section **183** performs the process of pasting the synthetic image of the region E**11**+E**12** generated by such a synthesis in a region E**1** corresponding to the synthetic images retained in the synthetic image retaining section **185**.

Further, the synthesis target image **462** (two layer images) which becomes the current synthesis target and the synthetic image generated by the current synthesis process are retained in the synthetic image retaining section **185** and are used for the next synthesis process. An example of the synthetic image generated in this way is shown in FIG. **12**B.

In this way, as the respective layer images are synthesized according to the priority, with respect to a region (for example, region E**12**) which is overlapped between continuous images in the synthesis process, the synthetic image can be generated without damaging a part of the target object. Thus, in a case where the synthetic image is generated using a plurality of synthesis target images, it is also possible to generate the motion transition images capable of appropriately expressing motions of the target object.

In this way, the synthetic image **460** generated by the layer synthesizing section **183** is stored in a synthetic image storing section **200**. Further, for example, the synthetic image **460** is displayed on the display section **191** according to the user manipulation. Further, for example, whenever the synthetic image is generated by the layer synthesizing section **183**, it may be automatically displayed on the display section **191**. FIG. **13** illustrates an example of the synthetic image generated in this way.

[Synthetic Image Example]

FIG. **13** is a diagram illustrating an example of a synthetic image generated by the layer processing section **180** according to the first embodiment of the present invention. A synthetic image **470** shown in FIG. **13** indicates motion transitions of a person who practices a golf swing. In the synthetic image **470**, a region indicated by an arrow **471** is a region including an image corresponding to a position where an impact sound is generated.

[Operation Example of Image Capturing Apparatus]

FIG. **14** is a flowchart illustrating an example of a process procedure of a synthetic image generation process by means of the image capturing apparatus **100** according to the first embodiment of the present invention.

Firstly, it is determined whether a setting manipulation of a synthetic image recording mode is performed (step S**901**). For example, it is determined whether a press manipulation of a setting button of the synthetic image recording mode or a timer setting button is performed. In a case where the setting manipulation of the synthetic image recording mode is not performed (step S**901**), monitoring is continued until the setting manipulation of the synthetic image recording mode is performed. In a case where the setting manipulation of the synthetic image recording mode is performed (step S**901**), the image capturing section **111** performs the generation process of the captured image (step S**902**), and the generated captured image is retained in the captured image retaining section **115** (step S**903**). That is, the buffering process is performed.

Subsequently, it is determined whether the press manipulation of the video recording button is performed (step S**904**). In a case where the press manipulation of the video recording button is performed, the valid sound range setting section **160** sets the valid sound range on the basis of the press position (step S**905**). For example, as shown in FIG. **5**A, the valid sound range **352** is set on the basis of the video recording button press position **351**. On the other hand, in a case where the press manipulation of the video recording button is not performed (step S**904**), it is determined whether the count value of the timer set by the timer setting section **150** is "0" (step S**906**). In a case where the count value of the timer is "0" (step S**906**), the valid sound range setting section **160** sets the valid sound range on the basis of the position where the count value of the timer is "0" (step S**907**). For example, as shown in FIG. **7**A, the valid sound range **382** is set on the basis of the time counter "0" position **381**. Further, in a case where the count value of the timer is not "0", or the timer setting is not performed by the timer setting section **150** (step S**906**), the procedure returns to step S**902**. Steps S**904** to S**907** represent an example of a valid sound range setting procedure disclosed in the claims.

Next, the buffering termination process is performed (step S**908**), and it is determined whether the impact sound is detected in the set valid sound range (step S**909**). In a case where the impact sound is detected in the set valid sound range (step S**909**), the synthesis target image selection range determining section **171** determines the synthesis target image selection range on the basis of the position where the impact sound is detected (step S**910**). For example, as shown in FIG. **5**C, the synthesis target image selection range **355** is determined on the basis of the impact sound detection position **353**. Further, for example, as shown in FIG. **7**C, the synthesis target image selection range **385** is determined on the basis of the impact sound detection position **383**. Steps **S909** and **S910** represent an example of a selection procedure disclosed in the claims.

Further, in a case where the impact sound is not detected in the set valid sound range (step **S909**), the synthesis target image selection range determining section **171** determines the synthesis target image selection range on the basis of the position which is a reference when the valid sound range is set (step **S911**). That is, in a case where the valid sound range is set on the basis of the press position of the video recording button, the synthesis target image selection range is determined on the basis of the press position. For example, as shown in FIG. **5**C, the synthesis target image selection range **355** is determined on the basis of the video recording button press position **351**. On the other hand, in a case where the valid sound range is set on the basis of the position where the count value of the timer is "0", the synthesis target image selection range is determined on the basis of the position. For example, as shown in FIG. **7**C, the synthesis target image selection range **385** is determined on the basis of the time counter "0" position **381**.

Subsequently, the synthesis target image selecting section **172** selects synthesis target images from the respective images included in the determined synthesis target image selection range (step **S912**). Then, the generation process of the synthetic image is performed using the selected synthesis target images (step **S913**).

Next, it is determined whether a release manipulation of the synthetic image recording mode is performed (step **S194**). In a case where the release manipulation of the synthetic image recording mode is not performed, the procedure returns to step **S902**, and the image synthesis process relating to the next synthetic image is subsequently performed. On the other hand, in a case where the release manipulation of the synthetic image recording mode is performed (step **S914**), the operation of the synthetic image generation process is terminated.

In this way, in the first embodiment of the present invention, a time span in which an impact sound which becomes the detection target can exist is set as the valid sound range, and thus, it is possible to reduce false detection of sounds other than the impact sound which becomes the detection target. Thus, in a case where a synthetic image using an extremely fast motion causing the impact sound such as a golf swing as a target is generated, it is possible to detect the generation position of the impact sound with a high degree of accuracy. Further, it is possible to generate the synthetic image with the emphasis around the accurate generation position of the impact sound, and to generate the synthetic image having a high visibility. In this case, since a manual work of the user is unnecessary for the detection of the generation position of the impact sound, it is possible to reduce user's inconvenience.

Further, as described above, it may be determined whether the synthetic image is generated according to whether the impact sound is detected in the valid sound range. This example is shown in FIG. **15**.

FIG. **15** is a flowchart illustrating an example of a process procedure of the synthetic image generation process by means of the image capturing apparatus **100** according to the first embodiment of the present invention. This example is a modified example of the process procedure of the synthetic image generation process shown in FIG. **14**, in which step **S911** is omitted. Thus, the same reference numerals are given to the same process steps as shown in FIG. **14**, and description thereof will be omitted.

It is determined whether the impact sound is detected in the valid sound range set in step **S905** or **S907** (step **S909**). In a case where the impact sound is not detected in the set valid sound range (step **S909**), the procedure goes to step **S914**. That is, in a case where the impact sound is not detected in the set valid sound range, the generation process of the synthetic image is performed using the press position of the next video recording button, or the position where the count value of the timer is "0", without generating the synthetic image. That is, the selecting section **170** performs a control, in a case where the impact sound is detected in the valid sound range, so that the synthetic image using the specific sound is generated in the layer processing section **180**, and performs a control so that the synthetic image is not generated in the layer processing section **180** in a case where the impact sound is not detected in the valid sound range.

In this way, in a case where the impact sound is not able to be detected in the valid sound range, it is possible to reduce a loss of a photographing chance for the user, by returning to the next photographable state without generating the synthetic image. Further, since the synthetic image can be generated using the accurate impact sound, it is possible to generate an appropriate synthetic image.

As the synthetic image is generated in this way, even a beginner who is not accustomed to the handling of the image capturing apparatus can easily generate an appropriate synthetic image.

In a case where the captured images generated by the image capturing section **111** are recorded as image contents (for example, a moving image file or continuous still image file), the impact sound detection position may be recorded as metadata of frame. Thus, for example, in a case where a list of the image contents is displayed, the frame corresponding to the impact sound detection position can be used as a representative thumbnail.

2. Second Embodiment

In the first embodiment of the present invention, the case where the distance between the image capturing apparatus and the target object (person who practices the golf swing) is relatively short has been described by way of example. However, the image capturing apparatus may be located in a position where the distance from the target object is relatively long and may photograph the target object by means of a zoom function of the image capturing apparatus. In such a case where the distance between the image capturing apparatus and the target object is relatively long, the time until the impact sound reaches the image capturing apparatus becomes long according to the length of the distance. In this case, a delay occurs between the time when the impact sound is generated and the time when the impact sound reaches the image capturing apparatus. Thus, the second embodiment of the present invention provides an example in which the detection position of the impact sound in the time axis is corrected, in a case where the distance between the image capturing apparatus and the target object is relatively long, according to the length of the distance.

FIGS. **16**A and **16**B are diagrams illustrating the distance between an image capturing apparatus **500** and a target object and the relation between a generation position of an impact sound and an arrival position thereof, according to the second embodiment of the present invention. FIG. **16**A schematically illustrates the positional relation between the image capturing apparatus **500** and a person **540** who becomes an image capturing target by the image capturing apparatus **500**. Here, the distance between the image capturing apparatus **500** and the person **540** is referred to as a distance d. The relation between the image capturing apparatus **500** and the person

540 is approximately the same as the example shown in FIG. 3A, except that the distance d is different, and thus, description thereof will be omitted.

FIG. 16B schematically illustrates the relation between respective images forming a moving image generated by the image capturing section 111 shown in FIG. 17 and motion transitions of the person 540. An image group 550 represents the motion transitions of the person 540 in a state shown in FIG. 16A, in which respective images forming the image group 550 are arranged in the time axis. An image group 560 represents the respective images forming the moving image generated by the image capturing section 111 in the state shown in FIG. 16A, in which the respective images forming the image group 560 are arranged in the time axis. Here, the position (position in the time axis) where the impact sound is generated by the golf swing of the person 540 is represented as an impact sound generation position 555.

In this respect, the speed of sound in air is about 340m/sec. Thus, in a case where the distance d between the image capturing apparatus 500 and the person 540 is relatively long, the time until the impact sound reaches the image capturing apparatus 500 becomes long, and thus, a delay occurs between the time when the impact sound is generated and the time when the impact sound is input to the image capturing apparatus 500.

For example, it is assumed that the position of an image 551 among the images forming the image group 550 shown in FIG. 16B is the impact sound generation position 555. In this case, for example, in a case where the distance d is relatively short (several meters, for example), as indicated by an arrow 552, the image 551 corresponding to the position where the impact sound is generated and an image 561 generated when the impact sound is input to the image capturing apparatus 500 are approximately the same each other. On the other hand, in the case where the distance d is relatively long (340 m or longer, for example), as indicated by an arrow 553, the image 551 corresponding to the position where the impact sound is generated and an image 562 generated when the impact sound is input to the image capturing apparatus 500 are different from each other, thereby causing a delay. In this respect, even in the case where the distance d is relatively long, it is likely that an image on a display screen displayed on the display section 191 is viewed at approximately the same angle of view as in the case where the distance d is relatively short. For this reason, it may be difficult to correct the delay of the impact sound by a manual manipulation of a user. Thus, hereinafter, an example in which the delay of the impact sound generated according to the distance between the image capturing apparatus and the target object is corrected is shown.

[Configuration Example of Image Capturing Apparatus]

FIG. 17 is a block diagram illustrating an example of a functional configuration of an image capturing apparatus 500 according to the second embodiment of the present invention. The image capturing apparatus 500 is different from the image capturing apparatus 100 shown in FIG. 1 in that an object distance calculating section 510 is added, and a selecting section 520 is installed instead of the selecting section 170. The configuration other than these components is approximately the same as in the image capturing apparatus 100. Thus, the same reference numerals are given to common components, and description of a part thereof will be omitted.

The object distance calculating section 510 calculates distance (object distance) from the object included in the captured image generated by the image capturing section 111, and outputs the calculated object distance to the selecting section 520. For example, the object distance calculating section 510 detects a face of the person included in the captured image generated by the image capturing section 111, and calculates the object distance of the target object, using the detected face and the imaging information (for example, position of each lens and focus position) at the time of generation of the captured image. For example, a face detection method (for example, see Japanese Unexamined Patent Application Publication No. 2004-133637) through matching of a template in which luminance distribution information of the face is recorded and a content image can be used as the detection method of the face included in the captured image. Further, a face detection method based on a characteristic amount of a flesh-colored portion or a human face included in the captured image can be used. Through such a face detection method, the position and size of the person's face in the captured image can be calculated.

The selecting section 520 estimates the delay time of the impact sound on the basis of the object distance output from the object distance calculating section 510, and selects the synthesis target images in consideration of the delay time. Specifically, the synthesis target image selection range determining section 171 (shown in FIG. 2) of the selecting section 520 corrects the detection position (position in the time axis) of the specific sound detected by the specific sound detecting section 132, on the basis of the object distance output from the object distance calculating section 510. Further, the synthesis target image selection range determining section 171 determines the synthesis target image selection range on the basis of the position after correction (corrected position) and the valid sound range set by the valid sound range setting section 160. The synthesis target image selection range determining section 171 is an example of a delay time calculating section disclosed in the claims.

[Calculation Example of Object Distance]

Next, a distance calculation method for calculating the distance between the image capturing apparatus 500 and the target object will be described in detail with reference to the drawings. Here, the distance calculation method for estimating the distance between the image capturing apparatus 500 and the face using the size (reference value) of an ordinary human face will be described.

FIGS. 18A and 18B are diagrams schematically illustrating an image capturing range which is an image capturing target by the image capturing section 111 and the captured image displayed on a display section 191, according to the second embodiment of the present invention. FIG. 18A is a diagram schematically illustrating an image capturing range 570 in a case where a person 571 against a golf range is imaged, and FIG. 18B is a diagram illustrating a display example of the display section 191 for a captured image 575 corresponding to the image capturing range 570 shown in FIG. 18A.

For example, as shown in FIG. 18A, in a case where the person 571 is imaged against the golf range as an object, a range (image capturing range 570) where the person 571 is imaged is determined according to the position of the image capturing apparatus 500, the position of a zoom lens or the like. Further, as shown in FIG. 18B, light incident from the object included in the image capturing range 570 is converted into an captured image by the image capturing section 111, and the captured image (so-called through image) is displayed on the display section 191.

Here, the width of the image capturing apparatus 500 in the left and right direction is represented as an image capturing range width Wa, and the width of a face 572 of the person 571 included in the image capturing range 570 in the left and right direction is represented as a face width Wref, in the image capturing range **570** shown in FIG. **18**A. The face width Wref corresponds to the size of an ordinary human face, not the actual face width of the person **571**. Further, the width in the left and right direction of the captured image **575** shown in FIG. **18**B is represented as an image width Ww, and the width of a face **577** of a person **576** included in the captured image **575** in the left and right direction is represented as a face image width Wf. In this case, the ratio of the image capturing range width Wa to the face width Wref is generally the same as ratio of the image width Ww to the face image width Wf.

FIG. **19** is a top view schematically illustrating the positional relation between an image capturing range which is an image capturing target by the image capturing section **111** and a captured image displayed on the display section **191**, according to the second embodiment of the present invention. In an example shown FIG. **19**, the positional relation between the person **571** shown in FIG. **18**A and an image capturing element **112** and the display section **191** provided in the image capturing apparatus **500** is schematically shown. As shown in FIG. **19**, the distance from the image capturing apparatus **500** to the face **572** is represented as an object distance Df; the focus distance in the image capturing apparatus **500** is represented as a focus distance f; and the width of the image capturing element **112** is represented as an image capturing element width Wi. The image capturing range width Wa and the face width Wref are the same as those shown in FIG. **18**A.

As shown in FIG. **19**, if the light incident from the object included in the image capturing range **570** enters the image capturing element **112**, the captured image corresponding to the object included in the image capturing range **570** is generated, and then the generated captured image **575** is displayed on the display section **191**. Further, the width of the face on the image capturing element **112** in a case where the light incident from the face **572** of the person **571** enters the image capturing element **112** is a face width Wb on the image capturing element.

Here, the following two equations are established from the proportional relation with parallel lines.

$$Df/W\mathrm{ref}=f/Wb \qquad \text{Equation 1}$$

$$Wf/Ww=Wb/Wi \qquad \text{Equation 2}$$

Here, the equation 1 is changed into Df=f×Wref/Wb, and the equation 2 is changed into Wb=Wf×Wi/Ww. Then, Wb=Wf×Wi/Ww obtained by changing the equation 2 is replaced with the equation 1, to thereby calculate the following equation 3. This equation 3 is calculated on the basis of a basic physical law of a lens.

$$Df=W\mathrm{ref}\times(f/Wi)\times(Ww/Wf) \qquad \text{Equation 3}$$

Here, Wi (image capturing element width) and Ww (image width) are constant numbers, and the size of an ordinary human face is used as Wref. In this case, as Wf (face image width) is detected, it is possible to calculate Df (estimation distance to the face) using the equation 3.

For example, as shown in FIG. **18**A, in a case where the face **572** of one person is included in the image capturing range **570**, the face **577** is detected from the captured image **575** corresponding to the image capturing range **570** by the object distance calculating section **510**. In this way, in a case where the face is detected, the object distance calculating section **510** calculates the object distance Df using the width (face image width) of the detected face on the basis of the equation 3.

The second embodiment of the present invention provides an example in which the object distance is calculated using one reference value as the ordinary human face size. Here, the person who becomes the image capturing target may have different face sizes according to the person's attributes (for example, age and gender). For example, in a case where a child face is compared with an adult face, the face sizes may be different from each other. Further, in a case where a female face is compared with a male face, the face sizes may be different from each other. Thus, a plurality of reference values according to the person's attributes may be retained in the object distance calculating section **510**. Then, the object distance calculating section **510** may detect the attributes for the face detected from the captured image, and the object distance calculating section **510** may calculate the distance d using the reference value according to the attributes. In order to detect the attributes, for example, a detection method in which the respective attributes are detected by a weak learner using difference values of luminance between two points in the face image can be used (for example, see Japanese Unexamined Patent Application Publication No. 2009-118009).

[Correction Example of Delay Time]

FIGS. **20**A and **20**B are diagrams schematically illustrating a setting method of a valid sound range by means of the valid sound range setting section **160** and a determination method of a synthesis target image selection range by means of the synthesis target image selection range determining section **171**, according to the second embodiment of the present invention. Since this example is a modified example of FIGS. **5**A and **5**B, description of a part of common components will be omitted.

FIG. **20**A schematically illustrates a moving image **580** generated by the image capturing section **111** in a rectangular shape. Further, it is assumed that the position where the video recording button is pressed is the press position (video recording button press position **581**) of the video recording button in the time axis of the moving image **580** shown in FIG. **20**A. In this case, the valid sound range setting section **160** sets a valid sound range **582** on the basis of the video recording button press position **581**. Specifically, the valid sound range setting section **160** sets a range, which precedes the video recording button press position **581** by a time L**21** in the time axis, as the valid sound range **582**. Here, for example, the time L**21** can be 1.0 second, in a similar way to the time L**1** shown in FIG. **5**A. Further, the time L**21** may be longer than the time L**1**, and may be changed according to the size of the object distance calculated by the object distance calculating section **510**.

FIG. **20**B schematically illustrates a determination method of the synthesis target image selection range in a case where the impact sound is detected in the valid sound range **582** set by the valid sound range setting section **160**. In FIG. **20**B, the position (position in the time axis) where the impact sound is detected by the specific sound detecting section **132** is represented as an impact sound detection position **583**.

In the second embodiment of the present invention, before determination of whether the impact sound is detected in the valid sound range **582**, the synthesis target image selection range determining section **171** estimates the delay time of the sound on the basis of the object distance d(m) estimated by the object distance calculating section **510**. Specifically, the synthesis target image selection range determining section **171** estimates the delay time of the sound on the basis of the object distance d(m) estimated by the object distance calculating section **510**. As described above, since the speed of sound is 340 (m/s), the time×(sec) until the impact sound reaches the image capturing apparatus **500** can be calculated using the following equation 4.

$$x=d/340 \qquad \text{Equation 4}$$

The synthesis target image selection range determining section **171** moves the impact sound detection position **583** in the time axis by the time x calculated using the equation 4. The position after the movement is represented as a correction position **584**.

Subsequently, the synthesis target image selection range determining section **171** determines whether the correction position **584** is included in the valid sound range **582** set by the valid sound range setting section **160**. As shown in FIG. **20**B, in a case where the correction position **584** is included in the valid sound range **582** set by the valid sound range setting section **160**, the synthesis target image selection range determining section **171** determines the synthesis target image selection range on the basis of the correction position **584**. That is, the synthesis target image selection range determining section **171** determines a predetermined range before and after the correction position **584** in the time axis with reference to the correction position **584**, as a synthesis target image selection range **585**. Specifically, the synthesis target image selection range determining section **171** determines a range L**24**, which includes a range which precedes the correction position **584** by a time L**22** and a range which exceeds the correction position **584** by a time L**23** in the time axis, as the synthesis target image selection range **585**.

Here, the times L**22** to L**24** may be the same values as the times L**2** to L**4** shown in FIG. **5**B, for example. Further, the time L**24** may be longer than the time L**4**, and may be changed according to the size of the object distance calculated by the object distance calculating section **510**.

Further, for example, in a case where the distance between the image capturing apparatus **500** and the person **540** is relatively distant, a timer setting can be performed by a remote controller manipulation. Thus, in a case where the valid sound range is set on the basis of the count value of the timer set by the timer setting section **150** and the synthesis target image selection range is determined using the valid sound range, similarly, the delay time of the sound may be estimated and the correction may be performed on the basis of the delay time.

In this way, even in the case where the distance between the image capturing apparatus **500** and the person **540** is relatively distant, the detection position of the impact sound is corrected to determine the synthesis target image selection range on the basis of the position after correction. Thus, it is possible to determine an appropriate synthesis target image selection range.

Here, the correction position may not exist in the valid sound range **582** set by the valid sound range setting section **160**. In this case, in a similar way to the example in FIG. **5**C, the impact sound is not used. Further, in a case where the impact sound is not used, as shown in FIG. **5**C, the synthesis target image selection range can be determined on the basis of the press position of the video recording button.

In FIGS. **18**A, **18**B and FIG. **19**, an example where the object distance is calculated using the size of the person's face is shown, but as shown in FIG. **21**, the object distance may be calculated by the size of portions other than the face.

[Calculation Example of Object Distance]

FIG. **21** is a diagram illustrating a display example in the display section **191** according to the second embodiment of the present invention. Manipulation support images **592** and **593** for arranging a person **591** who performs a golf swing in an appropriate position are displayed to be overlapped on a captured image, in a display screen **590** shown in FIG. **21**. This example is a modified example of the calculation method of the object distance shown in FIGS. **18**A and **18**B and FIG. **19**, and is an example in which the object distance is calculated on the basis of the size (length in the vertical direction) of a region occupied by the object in the display screen **590**.

The manipulation support images **592** and **593** represent recommendation regions in which the person **591** who performs the golf swing is to be arranged in the display screen **590**. The manipulation support image **592** is indicated by a black line in the display screen **590** and represents the recommendation region of the person **591** who performs the golf swing in the left and right direction. Further, the manipulation support image **593** is indicated by a dotted black frame in the display screen **590** and represents the recommendation region of the person **591** who performs the golf swing in the up and down direction. Here, the recommendation region in the up and down direction specified by the manipulation support image **593** can be a value H**11** of a predetermined ratio (for example, 70%) of the length of the display screen **590** in the vertical direction.

For example, in a case where photographing is performed by setting the synthetic image recording mode using the image capturing apparatus **500**, a photographer confirms the manipulation support images **592** and **593** included in the display screen **590** and performs an adjustment so that the person of the target object is included in the manipulation support images **592** and **593**. Further, in a case where a zoom manipulation or the like is performed, similarly, the photographer performs an adjustment so that the person of the target object is included in the manipulation support images **592** and **593**.

In this way, by applying the object distance calculation method for calculating the object distance on the basis of the reference value relating to the face as described above and the size of the face included in the captured image, it is possible to calculate the object distance. That is, since the size of the person included in the captured image can be the predetermined value H**11** in the example shown in FIG. **21**, the object distance can be calculated on the basis of the reference value (for example, 170 cm) relating to an ordinary height of the person who plays golf and the predetermined value H**11**.

In the examples shown in FIGS. **18**A, **18**B, FIG. **19**, and FIG. **21**, the object distance is calculated using the size of each portion of the person, but other object distance calculation methods may be used. For example, a depth map relating to the captured image may be generated and the object distance may be calculated using the depth map. Further, a distance measurement sensor may be installed in the image capturing apparatus **500** and the object distance measured by the distance measurement sensor may be used. Furthermore, the object distance may be calculated using focus position information.

Further, any one of the object distance calculation method using the focus position information and the object distance calculation method using the zoom position information may be selected for use according to photographing situations. For example, in a case where a focus is formed in a zoom position of a wide edge, it is likely that the focus position information has a higher accuracy than the zoom position information. For this reason, in a case where the focus is formed in the zoom position of the wide edge, the object distance calculation method using the focus position information can be selected. Further, the object distance may be estimated by a specific method, and it may be determined whether to use the estimation result or to perform re-estimation by other methods with reference to the estimation result.

[Operation Example of Image Capturing Apparatus]

FIG. **22** is a flowchart illustrating an example of a process procedure of a synthetic image generation process by means of the image capturing apparatus **500** according to the second embodiment of the present invention. This example is a modified example of the process procedure of the synthetic image generation process shown in FIG. **14**, in which step S**921** is added and a process procedure of steps S**922** and S**923** is performed instead of step S**910**. Thus, the same reference numerals are given to the same process procedure as shown in FIG. **14**, and description thereof will be omitted.

After a buffering termination process is performed (step S**908**), the object distance calculating section **510** calculates the object distance (step S**921**).

Further, in a case where the impact sound is detected in the set valid sound range (step S**909**), the synthesis target image selection range determining section **171** corrects the impact sound detection position on the basis of the calculated object distance (step S**922**). Specifically, the synthesis target image selection range determining section **171** calculates the delay time on the basis of the object distance, and subtracts the count value supplied from the counter section **174** by the calculated delay time to calculate a correction value. Then, the synthesis target image selection range determining section **171** specifies a position after correction of the impact sound detection position on the basis of the correction value. For example, as shown in FIG. **20**B, the impact sound detection position **583** is moved by the correction value x to calculate the correction position **584**.

Subsequently, the synthesis target image selection range determining section **171** determines the synthesis target image selection range on the basis of the position after correction (correction position) (step S**923**). For example, as shown in FIG. **20**B, the synthesis target image selection range **585** is determined on the basis of the correction position **584**.

In this way, according to the second embodiment of the present invention, it is possible to detect the generation position of the impact sound with a high accuracy, without relying on the change in the distance between the image capturing apparatus **500** and the target object due to the zoom manipulation. Thus, it is possible to generate the synthetic image having a high visibility, without relying on the change in the distance between the image capturing apparatus **500** and the target object due to the zoom manipulation. Further, since the manual work of the user is unnecessary, it is possible to reduce the user's inconvenience.

Further, for example, in a case where the captured images generated by the image capturing section **111** are recorded as the image contents, when the metadata is recorded in relation to the image contents, it is possible to record the impact sound detection position after correction. Thus, since the impact sound detection position after correction can be used in a case where the image file is reproduced, it is possible to detect the correct generation position of the impact sound. Further, for example, in a case where a list of the image contents is displayed, a frame corresponding to the impact sound detection position after correction can be used as a representative thumbnail.

3. Third Embodiment

The first and second embodiments of the present invention mainly provide the examples in which the motion transitions of the person who performs the golf swing are generated as the synthetic image. Here, for example, in the case of sport other than golf such as a ball hitting game or an object collision game, a characteristic sound is generated at the moment when a player hits a ball or objects collide with each other. Further, for example, in the case of fireworks, an explosion sound is generated at a splendidly exploding moment. As the synthesis target image selection range is determined using these specific sounds, an appropriate synthetic image can be generated. In this respect, the third embodiment of the present invention provides an example in which such a synthetic image is easily generated according to the user's preference.

[Configuration Example of Image Capturing Apparatus]

FIG. **23** is a block diagram illustrating an example of a functional configuration of an image capturing apparatus **600** according to the third embodiment of the present invention. The image capturing apparatus **600** is different from the image capturing apparatus **500** shown in FIG. **17** in that a target object information storing section **610** is added and a part of other components are modified. That is, the image capturing apparatus **600** is provided with a specific sound detecting section **620**, a valid sound range setting section **630** and a selecting section **640**, instead of the specific detecting section **132**, the valid sound range setting section **160** and the selecting section **520** in the image capturing apparatus **500**. The configuration other than these components is approximately the same as the image capturing apparatus **500**. Thus, the same reference numerals are given to common components, and description of a part thereof will be omitted.

Hereinafter, an example of conditions (a first condition and a second condition, for example) of a specific motion (for example, sport or the like) suitable for the selection process of the synthesis target image according to the embodiments of the present invention will be described. The first condition is that a body portion of a target object basically exists in the same position throughout overall motions. Further, the second condition is that a rapid motion involving an impact sound exists among a series of motions. As an example of sport, other than golf, satisfying these conditions, batting of baseball, a tennis serve, breaking of roof tiles or the like can be exemplified. Further, an object such as fireworks, other than sport, can be exemplified. Thus, the third embodiment of the present invention provides an example in which such an object or sport becomes a target object.

The target object information storing section **610** stores information about specific sounds and valid sound ranges with respect to specific motions of a plurality of types of target objects, and supplies the respective stored information to the specific sound detecting section **620**, the valid sound range setting section **630** and the selecting section **640**. The stored contents of the target object information storing section **610** will be described in detail with reference to FIG. **24**. The target object information storing section **610** is an example of a storing section disclosed in the claims.

The specific sound detecting section **620** detects a specific sound on the basis of sounds output from the sound input section **131**, and outputs, in a case where the specific sound is detected, the fact to the selecting section **640**. Further, the specific sound detecting section **620** detects a sound of a specific value or higher relating to tennis (service) and roof tile breaking. In this respect, the third embodiment of the present invention provides an example in which each impact sound shown in an impact sound **611** in FIG. **24**, in addition to an impact sound relating to the golf swing, becomes a specific sound. For example, in baseball (batting) and tennis (service), a sound generated at the moment when a bat or a racket comes in contact with a ball in motion becomes the impact sound. Further, for example, in roof tile breaking, a sound generated at the moment when a hand comes in contact with roof tiles in motion becomes the impact sound. In addition, in fireworks, a sound generated at the moment when fireworks explode in the sky becomes the impact sound. In order to detect these sounds, the specific sound detection method according to the first embodiment of the present invention can be used.

Further, the specific sound detecting section **620**, the valid sound range setting section **630** and the selecting section **640** acquires target object information on a specific motion designated by a user manipulation from the target object information storing section **610**, among the specific motions of the plurality of types of target objects. Then, the specific sound detecting section **620**, the valid sound range setting section **630** and the selecting section **640** perform respective processes using the acquired target object information. In these respective processes, this example is approximately the same as the examples shown in the first and second embodiments of the present invention except that the value of the impact sound and the valid sound range or the like is different, and thus description thereof will be omitted.

[Storage Example of Target Object Information Storing Section]

FIG. **24** is a diagram illustrating an example of the stored contents of the target object information storing section **610** according to the third embodiment of the present invention. In the target object information storing section **610** are stored the impact sound **611**, a high speed motion range **612**, a valid sound range **613** and a synthesis target image selection range **614**.

Specific sound identification information (reference data) for detecting a specific sound (impact sound) by the specific sound detecting section **620** is stored in the impact sound **611**. The impact sound **611** shown in FIG. **24** discloses only words indicating a corresponding specific sound.

In the high speed motion range **612** is stored a range with intervals closer than other intervals for selection of synthesis target images, in the synthesis target image selection range. For example, in a case where the specific motion due to the target object is baseball (batting), it may be considered that the motion transitions around the moment when a baseball bat comes in contact with a ball are minutely confirmed. Thus, in the synthesis target image selection range, a high speed motion range in which intervals of the images around the moment may be closer than other intervals for selection of the synthesis target images is set. In this high speed motion range, a predetermined range around the impact sound is set, for example.

The valid sound range **613** stores the valid sound range which becomes the setting target by the valid sound range setting section **630**. The third embodiment of the present invention provides an example in which the press manipulation of the video recording button is used as the photographing trigger. In a similar way to the examples shown in the first and second embodiments of the present invention, in the golf and baseball (batting), the photographing trigger may be generated after the motion which is the target is terminated. In the case of the fireworks, the photographing trigger may be generated at the moment when fireworks are exploded in the sky. Further, in a similar way to the examples shown in the first and second embodiments of the present invention, in the golf, baseball (batting) and fireworks, a specific range before the photographing trigger may be set as the valid sound range.

In addition, in the case of tennis (service), the photographing trigger may be generated at the moment when a player turns up for a predetermined time. In the roof tile breaking, the photographing trigger may be generated at the moment when the face of a person who breaks the roof tiles is full of fighting spirit. Further, in the tennis (service) and roof tile breaking, a specific range before a sound of a specific value or higher is initially detected from the photographing trigger can be set as the valid sound range. In this way, in the case of the tennis (service) and roof tile breaking, a rear edge of the valid sound range is set corresponding to the time when the sound of the specific value or higher is detected. However, in a case where the sound is not detected over a predetermined time, the sound detection may become invalid, and then a new valid sound range may be set. For this new valid sound range, the photographing trigger is newly generated. Accordingly, it is possible to reduce a false detection of an impact sound. In this respect, the sound of the specific value or higher in the tennis (service) and roof tile breaking is detected by the specific sound detecting section **620**.

In the synthesis target image selection range **614** is stored a synthesis target image selection range determined by the synthesis target image selection range determining section **171**. The third embodiment of the present invention provides an example in which a specific range with reference to the impact sound detected in the valid sound range is set as the synthesis target image selection range.

[Display Example of Designation Screen of Target Object]

FIG. **25** is a diagram illustrating a display example of (display screen **660**) of the display section **191** according to the third embodiment of the present invention. The display screen **660** is provided with a golf (swing) button **661**, a baseball (batting) button **662**, a tennis (service) button **663**, a roof tile breaking button **664** and a firework button **665**. Further, the display screen **660** is provided with a return button **666** and a determination button **667**.

The golf (swing) button **661**, the baseball (batting) button **662**, the tennis (service) button **663**, the roof tile breaking button **664** and the firework button **665** are pressed to designate the sport type which is a target when a synthetic image is generated for motion transitions. For example, in a case where the display section **191** is made of a touch panel, the designation can be performed by a press manipulation of a desired button.

The determination button **667** is pressed to determine the designation after the press manipulation for designating the sport type which is the target of the synthetic image. Through this press, the synthesis target image recording mode is set.

The return button **666** is pressed to return to the display screen displayed right before, for example.

For example, in the display screen **660**, in a case where a desired button (for example, the tennis (service) button **663**) is pressed and the determination button **667** is pressed, a manipulation signal indicating the fact is output from the manipulation receiving section **140** to the respective sections. Then, the specific sound detecting section **620**, the valid sound range setting section **630** and the selecting section **640** acquire target object information (target object information about the tennis (service), for example) of the designated sport type from the target object information storing section **610**. Then, the specific sound detecting section **620**, the valid sound range setting section **630** and the selecting section **640** perform the respective processes using the acquired target object information.

[Synthetic Image Example]

FIGS. **26**A and **26**B are diagrams illustrating an example of a synthetic image generated by the layer processing section **180** according to the third embodiment of the present invention.

FIG. **26**A illustrates a synthetic image **671** in a case where a person who performs baseball batting is imaged. That is, the synthetic image **671** is a synthetic image generated using a moving image obtained by the image capturing operation started after the baseball (batting) button **662** shown in FIG. **25** is pressed and the determination button **667** is pressed.

FIG. **26**B illustrates a synthetic image **672** in a case where a person who performs tennis service is imaged. That is, the synthetic image **672** is a synthetic image generated using a moving image obtained by the image capturing operation started after the tennis (service) button **663** shown in FIG. **25** is pressed and the determination button **667** is pressed.

In this way, during specific motions other than a golf swing, a time span in which an impact sound which becomes the detection target can exist is set as the valid sound range, and thus, it is possible to reduce a false detection of sounds other than the impact sound which becomes the detection target. Thus, in a case where a synthetic image using an extremely fast motion causing the impact sound as a target is generated, it is possible to detect the generation position of the impact sound with a high degree of accuracy. Further, it is possible to generate the synthetic image with the emphasis around the accurate generation position of the impact sound, and to generate the synthetic image having a high visibility. In this case, since a manual work of the user is unnecessary for the detection of the generation position of the impact sound, it is possible to reduce user's inconvenience. As the synthetic image is generated in this way, even a beginner who is not accustomed to the handling of the image capturing apparatus can easily generate an appropriate synthetic image according to the user's preference.

4. Fourth Embodiment

The first to third embodiments of the present invention provide the examples in which the image capturing operation is performed by the image capturing apparatus and the synthetic image is generated using the impact sound generated at the time of the image capturing operation. Here, in the case of generating the synthetic image for the contents (for example, moving image contents) recorded by the image capturing apparatus, the synthetic image may be generated using the impact sound included in the contents. Further, for example, in the case of a golf game, a characteristic sound may be generated other than the impact sound, such as a great cheer of spectators after a golf swing. For this reason, the valid sound range may be set using the characteristic sound as a trigger, instead of the press manipulation of the video recording button or the timer setting. Thus, the fourth embodiment of the present invention provides an example in which the valid sound range is set using the characteristic sound instead of the press manipulation of the video recording button or the timer setting, and the synthetic image is generated for the moving image contents recorded by the image capturing apparatus.

[Configuration Example of Image Processing Apparatus]

FIG. **27** is a block diagram illustrating an example of a functional configuration of an image processing apparatus **700** according to the fourth embodiment of the present invention. The image processing apparatus **700** is different from the image capturing apparatus **600** shown in FIG. **23** in that the sound input section **131** and the timer setting section **150** are omitted and some other components are modified. That is, the image capturing apparatus **700** is provided with a target object information storing section **710**, an input section **720** and an object information generating section **730**, instead of the target object information storing section **610**, the image capturing section **111** and the object information generating section **120** in the image capturing apparatus **600**. Further, the image capturing apparatus **700** is provided with a specific sound detecting section **740**, a valid sound range setting section **750** and a selecting section **760**, instead of a specific sound detecting section **620**, the valid sound range setting section **630** and the selecting section **640** in the image capturing apparatus **600**. The configuration other then these components is approximately the same as in the image capturing apparatus **600**. Thus, the same reference numerals are given to common components, and description of a part thereof will be omitted.

The target object information storing section **710** stores information about specific sounds or valid sound ranges for specific motions of a plurality of types of target objects, and supplies the respective stored information to the specific sound detecting section **740**, the valid sound range setting section **750** and the selecting section **760**. The storing contents of the target object information storing section **710** will be described in detail with reference to FIG. **28**.

The input section **720** is an input section, through which the image contents (for example, moving image files) recorded by the image capturing apparatus such as a digital video camera are input. It is assumed that the image contents are contents in which metadata (for example, sound information, zoom information or focus position information) relating to respective frames at the time of the image capturing operation of moving images or continuous still images is recorded in relation to the respective frames, for example. The input section **720** supplies respective images (frames) for forming the input image contents to the captured image retaining section **115**, the display control section **190** and the specific sound detecting section **740**, at a predetermined interval. Further, the input section **720** outputs the respective images for forming the input image contents and attribute information (for example, lens position and focus position) about the images to the object distance calculating section **510** and the object information generating section **730**.

The object information generating section **730** generates object information about the respective images on the basis of the respective images supplied from the input section **720** and the attribute information about the images. Further, the object information generating section **730** supplies the generated object information to the captured image retaining section **115** to retain the object information therein, and also supplies the object information to the valid sound range setting section **750** and the selecting section **760**. As the object information, for example, information for detecting a specific change in the time axis between the respective images is generated, in addition to information for discerning a region of the target object and a background region thereof. For example, a face included in the image is detected, and attribute information about an expression, direction or the like of the face is generated. For example, an attribute such as delight, anger, sorrow or expression of pleasure, strain, face direction, mouth expression (opening/closing), eye expression (for example, wink) or the like may be detected, and the attribute information may be generated on the basis of the detection result. As the attribute detection method, for example, an identification method based on the characteristic amount extracted from the face image relating to the attribute which becomes the detection target can be used. That is, the characteristic amount extracted from the face image relating to the attribute which becomes the detection target is stored in advance as an identification dictionary. Further, the characteristic amount is extracted from the face image including the detected face, and the extracted characteristic amount is compared with the characteristic amount included in the identification dictionary, to thereby calculate the similarity between these characteristic amounts. In addition, in a case where the calculated similarity exceeds a threshold value, it is determined that the detected face is an attribute corresponding to the identification dictionary which becomes the calculation target of the similarity which exceeds the threshold value. Furthermore, for example, the above-described attribute detection method may be used (for example, refer to Japanese Unexamined Patent Application Publication No. 2009-118009).

The valid sound range setting section **750** detects a specific change in the time axis between the respective images, on the basis of the attribute information generated in this way. As this specific change, for example, a face change can be detected. For example, the change in expression at the time of delight, anger, sorrow, pleasure or strain, the change in the face direction, for example, in a case where the face direction is changed to the front side from below, the change at the time of opening or closing the mouth, or the change in eyes at the time of wink can be detected as a face change. Further, a case where the person's face comes on the screen or the person's face goes out of the screen may be detected as the specific change in the time axis between the respective images. Further, as information for detecting the specific change in the time axis between the respective images, brightness information indicating the brightness of the entire image and luminance value distribution information indicating a distribution state of luminance values in the image may be generated. Then, a specific change in the information may be detected as the specific change in the time axis between the respective images.

The specific sound detecting section **740** detects the specific sound on the basis of the sound included in the image contents supplied from the input section **720**, and then outputs, in a case where the specific sound is detected, the fact to the valid sound range setting section **750** and the selecting section **760**. The impact sound which becomes the detection target by the specific sound detecting section **740** is the same as in the third embodiment of the present invention. Further, in the fourth embodiment of the present invention, when the specific change in the time axis between the respective images is detected, the specific sound detected by the specific sound detecting section **740** is used. For example, great cheers (wild applauses) of spectators in a case where a golf or baseball game is held, or a shout at the moment when fighting spirit is put into roof tile breaking is detected as the specific sound. Further, for example, a whistling sound of a piper or a splash sound of the water (for example, in a case where the target object relates to the water) may be detected as the specific sound. Further, the valid sound range setting section **750** detects the change in the specific sound as the specific change in the time axis between the respective images. For example, the time when the great cheers are detected from a state where the sound barely exists, or the time when the sound barely exists from the state where the great cheers are detected, can be detected as the specific change in the time axis between the respective images. As the specific sound detection method, the specific sound detection method shown in the first embodiment of the present invention can be applied. That is, the valid sound range setting section **750** can detect the specific change using at least one of the characteristic amount extracted from the respective images and the characteristic amount extracted on the basis of the sound in relation to the respective images. The valid sound range setting section **750** is an example of a specific change detecting section disclosed in the claims.

The specific sound detecting section **740**, the valid sound range setting section **750** and the selecting section **760** acquire target object information about the specific motion designated by the user manipulation among the specific motions of the plurality of types of target objects, from the target object information storing section **710**. Further, the specific sound detecting section **740**, the valid sound range setting section **750** and the selecting section **760** perform the respective processes using the acquired target object information. The respective processes are approximately the same as the examples as shown in the first to third embodiments of the present invention, except that the trigger when the impact sound is set, the impact sound, the value of the valid sound range and the like are different, and thus, description thereof will be omitted.

[Storage Example of Target Object Information Storing Section]

FIG. **28** is a diagram illustrating an example of stored contents of the target object information storing section **710** according to the fourth embodiment of the present invention. In the target object information storing section **710** are stored an impact sound **711**, a high speed motion range **712**, a trigger **713** for determining a valid sound range, a valid sound range **714** and a synthesis target image selection range **715**. The impact sound **711**, the high speed motion range **712** and the synthesis target image selection range **715** are approximately the same as the impact sound **611**, the high speed motion range **612** and the synthesis target image selection range **614** shown in FIG. **24**, and thus, description thereof will be omitted.

The trigger **713** for determining the valid sound range stores a trigger when the valid sound range is set by the valid sound range setting section **750**. For example, in the case of golf and baseball (batting), the trigger may be generated at the moment when the great cheer of spectators is detected in the contents input from the input section **720**. The detection of the great cheer of spectators is performed by the valid sound range setting section **750** on the basis of the specific sound detected by the specific sound detecting section **740**. Further, in the case of fireworks, the trigger may be generated at the moment when a dark state in the screen is transited to a bright state in the contents input from the input section **720**. The detection of the moment when the dark state in the screen is transited to the bright state is performed by the valid sound range setting section **750**, on the basis of the attribute information generated by the object information generating section **730**. Further, in the case of tennis (service), the trigger may be generated at the moment when a player turns up for a predetermined time in the contents input from the input section **720**. The detection of the moment when the player turns up for the predetermined time is performed by the valid sound range setting section **750**, on the basis of the attribute information generated by the object information generating section **730**. Further, in the case of roof tile breaking, the trigger may be generated at the moment when the face of a person who performs roof tile breaking is full of fighting spirit in the contents input from the input section **720**. The detection of the moment when the face of a person who performs roof tile breaking is full of fighting spirit is performed by the valid sound range setting section **750**, on the basis of the attribute information generated by the object information generating section **730** or the specific sound detected by the specific sound detecting section **740**.

The valid sound range **714** stores the valid sound range which becomes the setting target by the valid sound range setting section **750**. The fourth embodiment of the present invention provides an example in which the detection time of the specific change stored in the trigger **713** for determining the valid sound range is the trigger of the valid sound range. This valid sound range is approximately the same as the valid sound range **613** shown in FIG. **24**, except that the detection time of the specific change stored in the trigger **713** for determining the valid sound range is the trigger of the valid sound range, and thus, description thereof will be omitted.

[Determination Example of Synthesis Target Image Selection Range]

FIGS. **29**A and **29**B are diagrams schematically illustrating a setting method of a valid sound range by means of the valid sound range setting section **750** and a determination method of a synthesis target image selection range by means of the synthesis target image selection range determining section **171**, according to the fourth embodiment of the present invention. This is an example in which the synthesis target image selection range is determined in a case where the baseball (batting) shown in FIG. **28** is designated. Further, this example is a modified example in FIGS. **5**A and **5**B, and thus, description of a part of common components will be omitted.

FIG. **29**A schematically illustrates a moving image **800** input through the input section **720** in a rectangular shape. The moving image **800** is a moving image in which the appearance of a baseball game is recorded, for example. Further, in respective images for forming the moving image **800**, the position where the great cheer of spectators is detected by the specific sound detecting section **740** is represented as a great cheer detecting position **801** in the time axis of the moving image **800** shown in FIG. **29**A. In this case, the valid sound range setting section **750** sets a valid sound range **802** on the basis of the great cheer detection position **801**. Specifically, the valid sound range setting section **750** sets a range, which precedes the great cheer detection position **801** by a time L**31** in the time axis, as the valid sound range **802**. Here, the time L**31** can be 1.0 second, in a similar way to the time L**1** shown in FIG. **5**A, for example. Further, the time L**31** may be longer than the time L**1**.

For example, it is considered that a generation position of the impact sound when a player has a great shot in a golf tournament occurs prior to the great cheer of spectators. Thus, the valid sound range is set (in a preceding position in the time axis) prior to the great cheer of spectators, thereby making it possible to appropriately detect the impact sound.

FIG. **29**B schematically illustrates a determination method of the synthesis target image selection range in a case where the impact sound is detected in the valid sound range **802** set by the valid sound range setting section **750**. In FIG. **29**B, the position (position in the time axis) where the impact sound is detected by the specific sound detecting section **740** is represented as an impact sound detection position **803**.

For example, the synthesis target image selection range determining section **171** determines whether the impact sound detection position **803** is included in the valid sound range **802** set by the valid sound range setting section **750**. As shown in FIG. **29**B, in a case where the impact sound detection position **803** is included in the valid sound range **802**, the synthesis target image selection range determining section **171** determines the synthesis target image selection range on the basis of the impact sound detection position **803**. That is, the synthesis target image selection range determining section **171** determines a specific range before and after the impact sound detection position **803** in the time axis with reference to the impact sound detection position **803** as a synthesis target image selection range **804**. Specifically, a range L**34**, which includes a range which precedes with reference to the impact sound detection position **803** by a time L**32** in the time axis and a range which exceeds the impact sound detection position **803** by a time L**33**, is determined as the synthesis target image selection range **804**.

Here, the times L**32** to L**34** may be the same values as the times L**2** to L**4** shown in FIG. **5**B, for example. Further, the time L**34** may be longer than the time L**4**.

FIGS. **30**A and **30**B are diagrams schematically illustrating a setting method of a valid sound range by means of the valid sound range setting section **750** and a determination method of a synthesis target image selection range by means of the synthesis target image selection range determining section **171**, according to the fourth embodiment of the present invention. This is an example in which the synthesis target image selection range is determined in a case where the tennis (service) in FIG. **28** is designated. Further, this example is a modified example shown in FIGS. **5**A and **5**B, and thus, description of a part of common components will be omitted.

FIG. **30**A schematically illustrates a moving image **810** input through the input section **720** in a rectangular shape. The moving image **810** is a moving image in which the appearance of a tennis game is recorded, for example. Further, in respective images for forming the moving image **810**, the position where it is detected by the object information generating section **730** that a face of a tennis player turns up for a predetermined time or longer is represented as a face turn-up state detection position **811** of the moving image **800** in the time axis. Further, the position (position in the time axis) where a sound of a specific value or higher is detected by the specific sound detecting section **740** is represented as a sound detection position **812** of a specific value or higher. In this case, the valid sound range setting section **750** sets a valid sound range **813** on the basis of the face turn-up state detection position **811** and the sound detection position **812** of the specific value or higher. Specifically, the valid sound range setting section **750** sets the valid sound range **813** (time L**41**) in the time axis with reference to the face turn-up state detection position **811** and the sound detection position **812** of the specific value or higher. Here, the time L**41** is a range where the face turn-up state detection position **811** is a start point and the sound detection position **812** of the specific value or higher is an end point, for example.

In this respect, in the end point of the valid sound range relating to tennis (service), the detection of the sound of the specific value or higher is a setting condition. Here, in a case where the sound of the specific value or higher is not detected from the start point of the valid sound range for a predetermined time or longer, the valid sound range setting section **750** makes invalid the valid sound range relating to the start point, and may wait for a new trigger for determining the valid sound range. Thus, a false detection of the impact sound can be reduced. Further, the end point of the valid sound range relating to the roof tile breaking can be similarly applied.

FIG. **30**B schematically illustrates a determination method of a synthesis target image selection range in a case where the impact sound is detected in the valid sound range **813** set by the valid sound range setting section **750**. In FIG. **30**B, the position (position in the time axis) where the impact sound is detected by the specific sound detecting section **740** is represented as an impact sound detection position **814**.

For example, the synthesis target image selection range determining section **171** determines whether the impact sound detection position **814** is included in the valid sound range **813** set by the valid sound range setting section **750**. As shown in FIG. **30**B, in a case where the impact sound detection position **814** is included in the valid sound range **813**, the synthesis target image selection range determining section **171** determines the synthesis target image selection range on the basis of the impact sound detection position **814**. That is, the synthesis target image selection range determining section **171** determines a specific range before and after the impact sound detection position **814** in the time axis with reference to the impact sound detection position **814** as a synthesis target image selection range **815**. Specifically, a range L**44**, which includes a range which precedes the impact sound detection position **814** by a time L**42** in the time axis and a range which exceeds the impact sound detection position **814** by a time L**43**, is determined as the synthesis target image selection range **815**.

Here, as shown in FIG. **28**, the time L**42** can be 2.5 seconds, for example; and the time L**43** can be 0.5 seconds, for example. That is, the time L**44** can be 3.0 seconds. The setting contents of the times L**42** to L**44** may be changed according to user's preference.

Further, in the examples shown in FIGS. **29**A, **29**B and FIGS. **30**A and **30**B, before determination of whether the impact sound is detected in the valid sound range as shown in the second embodiment of the present invention, the delay time of the sound may be estimated, and the impact sound detection position may be corrected on the basis of the estimation result. In this way, the detection position of the impact sound is corrected, thereby making it possible to determine the synthesis target image selection range on the basis of the position after correction. Further, in the specific sound (for example, great cheer of spectators) which is the trigger of the valid sound range, the sound delay time may be estimated, and the detection position may be corrected on the basis of the estimation result. For example, in a case where the specific sound is the great cheer of spectators, the object distance to the background of the target object is calculated using metadata (for example, zoom information or focus position information) relating to respective frames, and the delay time of the great cheer of spectators can be estimated on the basis of the object distance. Thus, even in the moving image contents in which the target object which is relatively distant becomes an image capturing target by a zoom function, an appropriate synthesis target image selection range can be also determined.

Further, in the examples shown in FIGS. **29**A and **29**B and FIGS. **30**A and **30**B, the impact sound may not be detected in the valid sound range set by the valid sound range setting section **750**. In this case, a synthetic image is not generated using the impact sound, and the next synthetic image process may be performed.

In this way, with respect to the image contents recorded by the image capturing apparatus such as a digital video camera or the like, the valid sound range can be set using the specific change in the time axis between the respective images. Thus, in a case where the synthetic image in which an extremely fast motion causing the impact sound is a target is generated, it is possible to detect the generation position of the impact sound without pressing the video recording button or the like with a high level of accuracy. Further, it is possible to generate the synthetic image with the emphasis around the accurate generation position of the impact sound, and to generate the synthetic image having high visibility. Further, since manual work of the user is also unnecessary for the detection of the generation position of the impact sound, it is possible to reduce inconvenience for the user. As the synthetic image is generated in this way, even a beginner who is not accustomed to the handling of the image capturing apparatus can easily generate an appropriate synthetic image according to the user's preference.

The setting method for setting the valid sound range using the specific change in the time axis between the respective images may be employed to the image capturing apparatus shown in the first to the third embodiments of the present invention.

Further, in the embodiments of the present invention, the synthesis target images selected by the synthesis target image selecting section **172** are used for the generation process of the synthetic image as the still image. Here, for example, the selected synthesis target images may be used for the synthetic image generation process in which the process of generating the synthetic image is displayed as a moving image. Further, the selected synthesis target images may be used as the synthesis targets, and also, may be used as a plurality of images (for example, images used in a slide-show) indicating transitions of the specific motion.

The present embodiments can be applied to image processing apparatuses such as a mobile phone with an imaging function, personal computer, video system, editing apparatus or the like. Further, the process procedures in the present embodiments of the present invention may be also provided in a process program.

The embodiments of the present invention exemplify examples for realizing the present invention. Here, as obviously seen in the embodiments of the present invention, the disclosures in the embodiments of the present invention correspond to the disclosures in the claims, respectively. Similarly, the disclosures in the claims correspond to the disclosures in the embodiments of the present invention having the same reference numerals, respectively. Here, the present invention is not limited to the embodiments, may be variously modified within the range without departing from the spirit of the present invention.

Further, the process procedures described in the embodiments of the present invention may be provided as a method having the series of procedures. Further, the process procedures may be provided as a program for allowing the series of procedures to be executed on a computer and a recording medium which records the program. A CD (Compact Disc), MD (MiniDisc), DVD (Digital Versatile Disc), memory card, Blu-ray Disc (registered trademark) or the like may be used as this recording medium.

It should be understood by those skilled in the art that various modifications, combinations, sub-combinations and alterations may occur depending on design requirements and other factors insofar as they are within the scope of the appended claims or the equivalents thereof.

What is claimed is:

1. An image processing apparatus for generating a number of synthetic images representative of motion transitions, said apparatus comprising:

a memory device having stored thereon a program; and

a computer which upon execution of the program from the memory performs as

(i) a valid sound range setting section to set according to a user manipulation a first valid range indicative of a first time range with regard to received images arranged in a time-series manner, the first valid range having a first plurality of images associated therein in which a number of images in the first plurality of images is less than that in the received images;

(ii) a sound determination section to determine whether a specific sound is included in the first valid range; and

(iii) an image selection section to select a second plurality of images that continue in a time-series manner in a second valid range indicative of a second time range in a case the specific sound is determined to be included in the first valid range, the selected plurality of images are for use in generating the number of synthetic images,

the second valid range includes (i) a before portion which precedes a detection position of the specific sound detected in the set first valid range and (ii) an after portion which is after the detection position of the specific sound, said before portion being larger than said after portion such that a number of images in the before portion is larger than that in the second portion.

2. The apparatus according to claim **1**,

wherein the user manipulation relates to an image capturing operation.

3. The apparatus according to claim **1**, in which the computer upon execution of the program further performs as

a specific change detecting section to detect a specific change in time between the images.

4. The apparatus according to claim **3**,

wherein the specific change detecting section detects the specific change using at least one of a characteristic amount extracted from each image and a characteristic amount extracted on the basis of a sound relating to each image.

5. The image processing apparatus of claim **1**, in which the computer upon execution of the program further performs as

a synthetic image generating section to generate the number of synthetic images using the selected plurality of images along with layer images obtained therefrom.

6. The apparatus according to claim **5**, wherein the synthetic image generating section is configured to arrange and synthesize the layer images in a time-series manner.

7. The image processing apparatus of claim **5**, wherein the synthetic image generating section comprises:

a layer separating section configured to obtain a plurality of layer images by separating a target object from a background of the images.

8. The image processing apparatus of claim **1**, further comprising a display configured to display a plurality of types of motion selectable by a user to designate a selected type.

9. The image processing apparatus of claim **1**, in which the first time range is shorter than the second time range such that the first valid range set by the valid sound range setting section is shorter than the second valid range and the number of images in the first plurality of images is less than that of the second plurality of images.

10. An image processing apparatus for generating a number of synthetic images representative of motion transitions, said apparatus comprising:

a memory device having stored thereon a program; and

a computer which upon execution of the program from the memory performs as

(i) a valid sound range setting section to set a first valid range indicative of a first time range according to a user manipulation;

(ii) a sound determination section to determine whether a specific sound is included in the first valid range; and

(iii) an image selection section to select a plurality of images that continue in a time-series manner in a second valid range indicative of a second time range in a case the specific sound is determined to be included in the first valid range, the selected plurality of images are for use in generating the number of synthetic images,

in which the specific sound is contained in the second valid range and the second valid range is overlapped with the first valid range,

wherein the user manipulation is a specific manipulation received when motion of a target object is terminated or a timer setting manipulation for such a setting that a termination time of the motion of the target object becomes a termination time of a time counter, and

wherein the valid sound range setting section sets the first valid range with reference to a position in time where the specific manipulation is received in a case where the user manipulation is the specific manipulation, and sets the first valid range with reference to the termination time of the time counter by means of the timer setting manipulation in a case where the user manipulation is the timer setting manipulation.

11. The apparatus according to claim **10**,

wherein the valid sound range setting section narrows the first valid range set in the case where the user manipulation is the specific manipulation compared with the first valid range set in the case where the user manipulation is the timer setting manipulation.

12. An image processing apparatus for generating a number of synthetic images representative of motion transitions, said apparatus comprising:

a memory device having stored thereon a program; and

a computer which upon execution of the program from the memory performs as

(i) a valid sound range setting section to set a first valid range indicative of a first time range according to a user manipulation;

(ii) a sound determination section to determine whether a specific sound is included in the first valid range; and

(iii) an image selection section to select a plurality of images that continue in a time-series manner in a second valid range indicative of a second time range in a case the specific sound is determined to be included in the first valid range, the selected plurality of images are for use in generating the number of synthetic images,

in which the specific sound is contained in the second valid range and the second valid range is overlapped with the first valid range,

said computer upon execution of the program further performs as

a storage section to store specific sounds and first valid ranges relating to a plurality of types of specific motions; and

a manipulation receiving section to receive a designating manipulation for designating a desired specific motion from among the plurality of types of specific motions in which the specific sounds and the first valid ranges are stored,

wherein the sound determination section determines the specific sound relating to the designated specific motion, and

wherein the valid sound range setting section sets the first valid range relating to the designated specific motion according to the user manipulation.

13. An image processing method for generating a number of synthetic images representative of motion transitions, said method comprising the steps of:

setting according to a user manipulation a first valid range indicative of a first time range with regard to received images arranged in a time-series manner, the first valid range having a first plurality of images associated therein in which a number of images in the first plurality of images is less than that in the received images;

determining whether a specific sound is included in the first valid range;

selecting a plurality of images that continue in a time-series manner in a second valid range indicative of a second time range in a case the specific sound is determined to be included in the first valid range; and

using the selected plurality of images in the generating of the number of synthetic images,

the second valid range includes (i) a before portion which precedes a detection position of the specific sound detected in the set first valid range and (ii) an after portion which is after the detection position of the specific sound, said before portion being larger than said after portion such that a number of images in the before portion is larger than that in the second portion.

14. A non-transitory medium comprising a program which allows a procedure to be executed on a computer, the procedure for generating a number of synthetic images representative of motion transitions, the procedure comprising the steps of:

setting according to a user manipulation a first valid range indicative of a first time range with regard to received images arranged in a time-series manner, the first valid range having a first plurality of images associated therein in which a number of images in the first plurality of images is less than that in the received images;

determining whether a specific sound is included in the first valid range;

selecting a plurality of images that continue in a time-series manner in a second valid range indicative of a second time range in a case the specific sound is determined to be included in the first valid range; and

using the selected plurality of images in the generating of the number of synthetic images,

the second valid range includes (i) a before portion which precedes a detection position of the specific sound detected in the set first valid range and (ii) an after portion which is after the detection position of the specific sound, said before portion being larger than said after portion such that a number of images in the before portion is larger than that in the second portion.

15. An image processing apparatus for generating a number of synthetic images representative of motion transitions, said apparatus comprising:

a memory device having stored thereon a program; and

a computer which upon execution of the program from the memory performs as

(i) a valid sound range setting section to set a first valid range indicative of a first time range according to a user manipulation;

(ii) a sound determination section to determine whether a specific sound is included in the first valid range; and

(iii) an image selection section to select a plurality of images that continue in a time-series manner in a second valid range indicative of a second time range in a case the specific sound is determined to be included in the first valid range, the selected plurality of images are for use in generating the number of synthetic images,

wherein the first valid range is set based on one of the user manipulation: (i) a specific manipulation received in a case motion of a target object, generated by the plurality of images, is terminated, or (ii) a timer setting manipulation for such a setting that a termination time of the motion of the target object is met.

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